POWER

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OLD SAUERFLEISCH certainly had a pat name. The United States equivalent for sauerfleisch is sour meat, and our "hero" was all of that. A single glance from him was sufficient to turn perfectly good milk into pot cheese. Dogs never attempted to be friendly with the old crust—they knew instinctively that it was useless. To be concise, he had the reputat on of owning the best "chronic grouch" in six counties. He had very few sincere friends and no one ever succeeded in developing a pleasant acquaintance with him Only those salesmen who were strangers in his territory called on him and they seldom repeated the call more than once or twice. If possible, Sauerfleisch was worse than old Scrooge before his reformation—he seemed to hate even himself. Certain it is that he was of very little use to the community and but scant comfort to himself, for that matter. Nothing pleased him, nothing satisfied him even. He never was known to do a kindly deed or say a pleasant word.

About the only consolation that we can get out of this sad recital is the fact that Sauerfleisch was not an engineer. Then, of course, there is the moral—we're long on morals here on the front page as no doubt you have observed.

A pleasing contrast to Sauerfleisch's personality was that of Joy Openface. When people spoke of him, the terms most frequently used were: genial, jolly, friendly, decent, "good scout," good fellow and such like. He always had a friendly greeting, a cheering word, a sympathetic ear or a helping hand for anyone he might meet. In addition to this there was an indescribable something about him that caused one to feel instinctively that he was a friend. Not many of us are blessed naturally with this quality, but many succeed in creating a satisfactory substitute by careful self-training and by exercising self-control. When instinct and natural inclination prompt open hostility toward some stranger or even an uncongenial acquaintance, self-control dictates the use of dignified civility at the least

Old Sauerfleisch found life a continual strife, full of unpleasant encounters. His frequent plaint was that everyone antagonized him without cause.

With Openface it was the reverse. When the occasional need arose he always found a dozen or so to give him a boost over a rough spot.

Each reaped the natural fruit of his sowing.

There are many, many reasons why it pays to cultivate the habit of being open to friendly advances. It is easy enough to drop a man who does not prove to be worthy of your confidence and friendship, but it is often really difficult to develop an intimacy with a good man—one who wou'd make a valuable friend—once you have shown yourself unresponsive to his advances.

"Glad handing" is the description sometimes given of the practice of being open and cordial.

Being a disciple of the "glad hand" is not such a bad idea.

Hydroelectric Plant at Vernon, Vt.

About two years ago the Vernon, Vt., hydroelectric power plant of the Connecticut River Power Company was partly described in POWER, the plant then being in process of erection. All of the machinery has since been installed and the transmission lines have been completed.

The building has a steel skeleton framework with concrete substructure and brick superstructure. It is 250 feet long by 55 feet wide inside and contains eight generating units.

The power house forms part of the dam, as shown in Fig. 1. From the east end of the building the main dam extends to the east bank of the river and forms a spillway 600 feet long. The dam is of concrete built on rock foundations, and gives an operating head of about 34 feet.

This installation consists of eight 2500-kilowatt generators, each driven by three turbine wheels mounted on the same shaft. At the normal water level two wheels are active and the third and top wheel is put into service during flood periods when the effective head is reduced.

Ten flood gates are arranged through the base of the dam, and when flooded each gate will discharge about 2000 cubic feet of water per second. These 7x9-foot gates are motor operated and can be opened in about two hours. The motor is reversible and is also used to close the gates.

With the water at the crest of the dam, a pond 16 miles in length is obtained and with 4 feet of flashboards on the dam, which are generally used in the summer time, water is backed upstream about 31 miles. The area of the watershed above the dam is 6250 square miles.

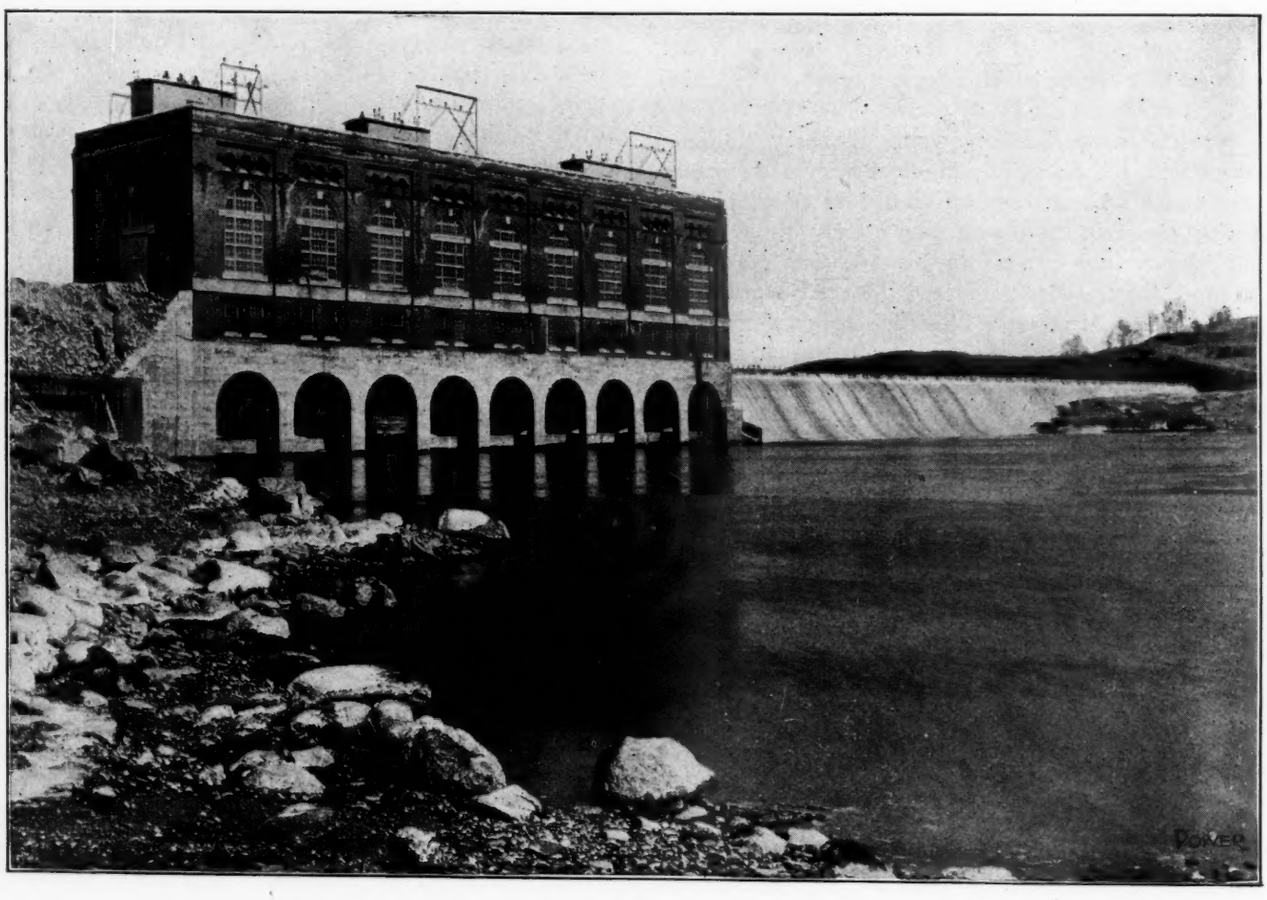

FIG. 1. LOOKING AT THE POWER HOUSE FROM BELOW THE DAM

WATERWHEELS AND GENERATORS

As one enters the door of the main generating room he sees eight General Electric generators installed in a row as shown in Fig. 3, each having a normal capacity of 2500 kilowatts and running at 133 revolutions per minute. The generators deliver three-phase 60-cycle currents at 2300 volts.

There are two exciting units which run at a speed of 190 revolutions a minute and deliver 2400 amperes at a voltage of 125. The speed of these exciter turbine wheels is governed by Lombard governors.

The waterwheel equipment for each generator consists of two 60-inch McCormick turbines in one wheel case at the bottom of the wheel pit. These two wheels in regular operation at normal head give sufficient power to drive the generator at its rated capacity. During the flood period the effective head is reduced so that a third wheel has been added above the other two, as shown in Fig. 4. Under all conditions of water the full rating from each generator is obtainable. The Lombard governors are of a type especially designed for this installation and are capable of giving full travel of the gates in 1½ seconds; they control the lower pair of runners only. The gate on the upper runner is manipulated by hand.

The entire weight of the waterwheels, vertical shaft and revolving field of the

generator is supported by a thrust bearing located in a chamber directly below the generators. Each unit has an independent triple-plunger oil pump supplying oil to its bearing at from 150 to 250 pounds pressure. An auxiliary pump connected to an auxiliary oil header furnishes oil for starting and stopping. This thrust bearing is the only support for the revolving element of each unit, weighing about 85,000 pounds, and has so far worked out very satisfactorily. The oil from the step bearing passes to a filter and from that to a supply tank from which the oil pumps take it to the step bearing. Oil for the main bearings on the vertical shaft is obtained from an overhead supply tank and after passing through a filter it is elevated to the overhead tank, the cycle being continuous. Each waterwheel is supplied with a step-bearing pump which maintains an oil supply while the waterwheel is in operation. There is also a pumping outfit which is driven by the exciter unit and is used for supplying step-bearing oil to the generator units when they are about to be started. As soon as a generator has come up to speed and its individual pump is capable of maintaining a proper step-bearing pressure the auxiliary step-bearing pump is stopped.

A signal system is used for starting and stopping the various units. For instance, if the operator in the generator room desires to start No. 1 turbine, he

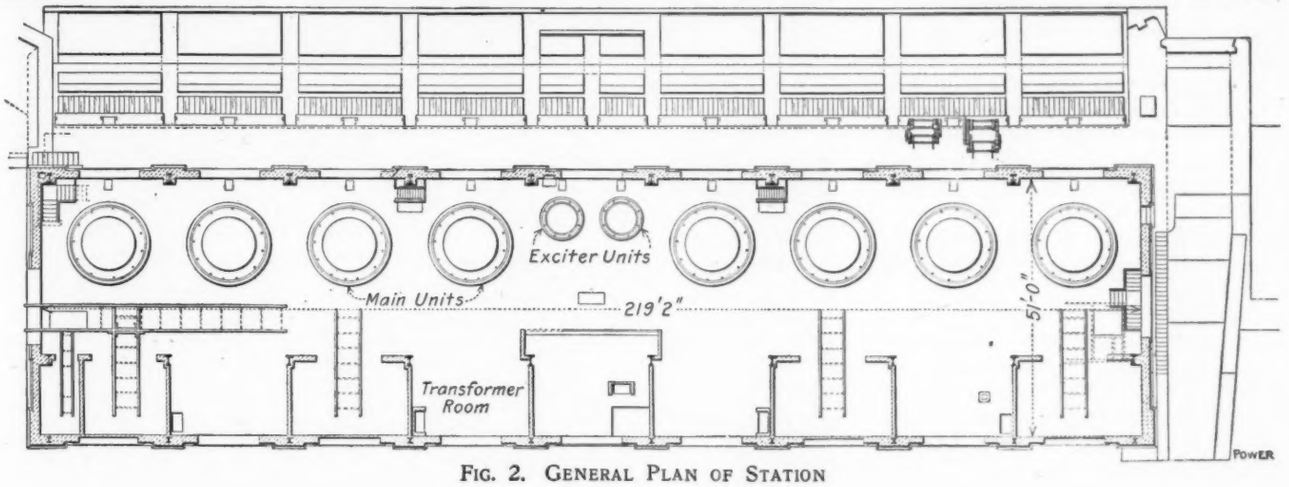

FIG. 2. GENERAL PLAN OF STATION

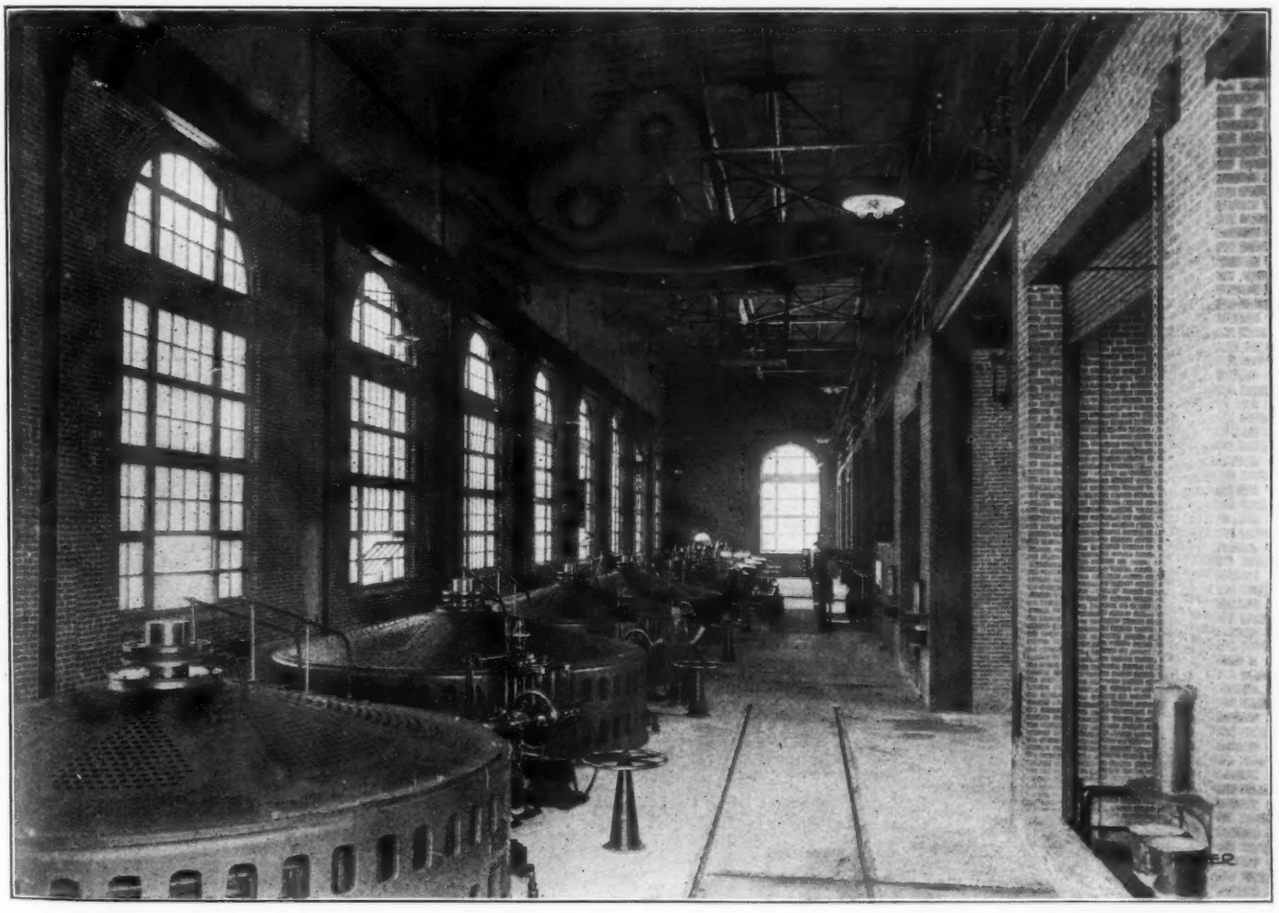

FIG. 3. THE GENERATOR ROOM

rings one bell as a signal to the step-bearing pump man who is stationed in the room below, shown in Fig. 5. At the same time one of eight switches is thrown which illuminates the "figure 1" on the signal board in the step-bearing room and another switch illuminates the word "start" on the same board. As soon as the step-bearing operator receives this signal he starts the auxiliary step-bearing pump. The attendant then throws in a duplicate switch which illuminates the word "start" and the "figure 1" on a signal board in the generator room.

Transformers

Four 5000-kilowatt, three-phase transformers are installed, each in a separate brick compartment, which raise the pressure from 2300 to 66,000 volts, the normal operating transmission voltage. An additional 900-kilowatt transformer is installed for transferring energy to a line reaching nearby territory at 19,000 volts. All the oil switches are of remote control and electrically operated, so that the switchboard panels contain control switches with pilot lamps and the necessary instruments, all operating at low voltage.

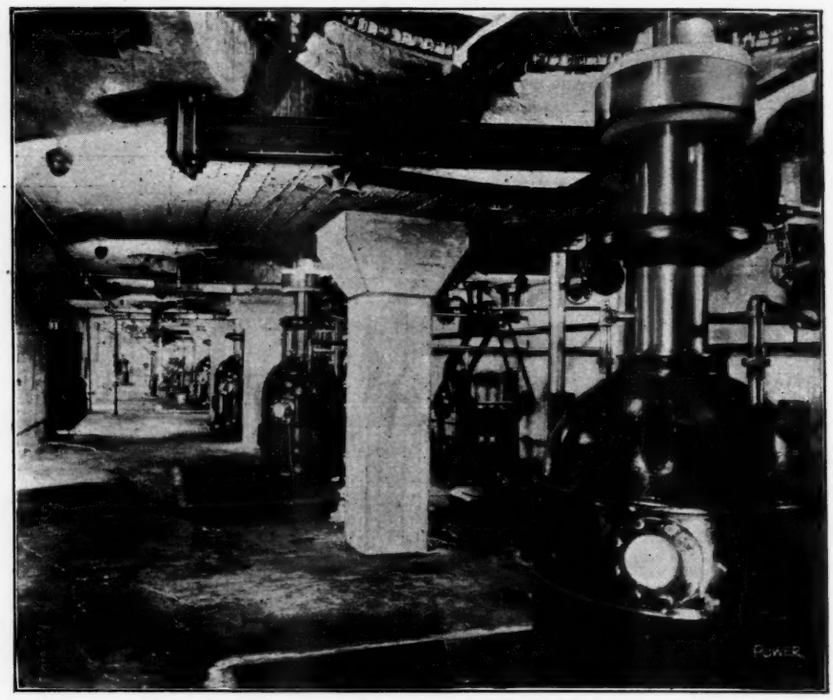

Fig. 5. Step-bearing Room Showing Step Bearings of the Various Generators

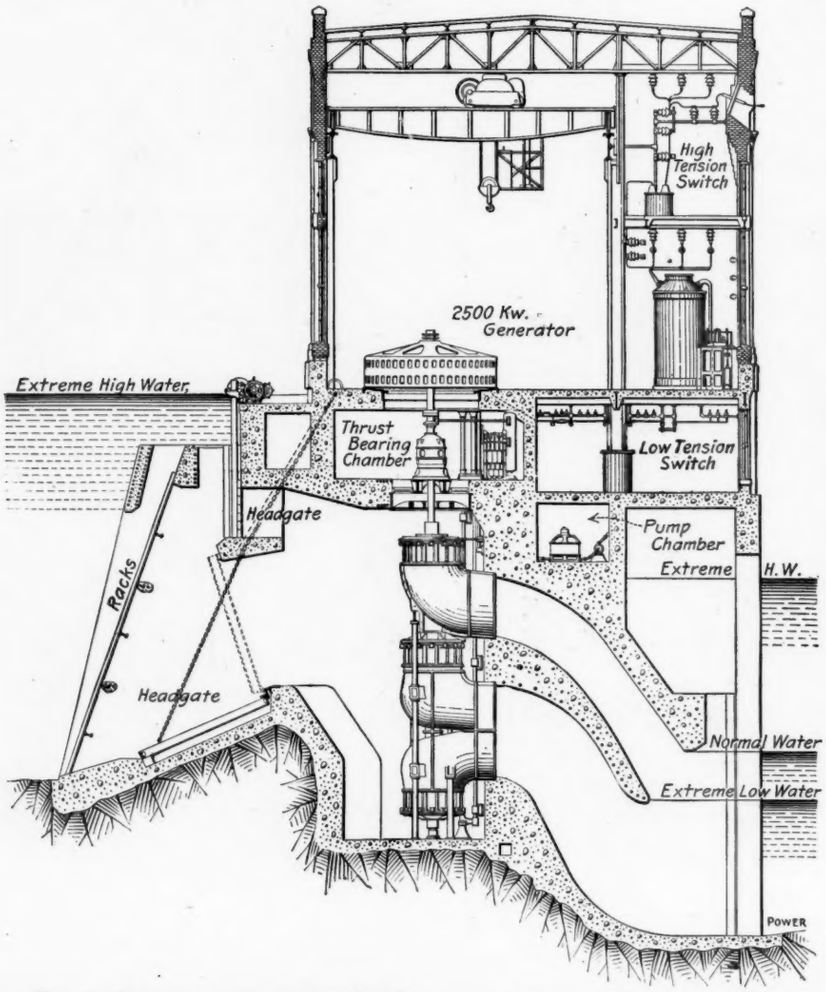

Fig. 4. Elevation of the Plant Showing Arrangement of the Three Turbine Waterwheels

The general wiring arrangement is such that a pair of generators are connected to a 5000-kilowatt transformer which is either connected to a 66,000-volt bus or to an individual transmission line. This keeps the 2300-volt wiring down to the lowest possible amount, although a 2300-volt bus is provided so that in an emergency any generator can be connected to any transformer. Each generator, transformer and line is provided with automatic inverse time-limit relays for protection against short-circuit or serious overloads.

Above the transformer rooms in the gallery running the entire length of the station are located the oil and knife switches.

To facilitate the handling of heavy machinery a 60,000-pound electric crane running the length of the building has been installed. A spur track enters the station for a short distance so that material can be unloaded from the cars and carried to any section of the plant by the crane. At the far end of the plant there is a motor-driven Clayton air compressor driven by a 15-horsepower motor. It is used to furnish compressed air for cleaning purposes such as blowing dust out of the generators, etc.

Switchboard

Midway of the generator room is the black marble switchboard, which is made up of eight generator panels, eight transformer panels and two exciter panels. There is also one panel for the lighting line of the plant and one motor panel for controlling the circuit running

to the motors in the basement. A plan view of the plant is shown in Fig. 2.

In the basement in a room separate from the step-bearing room and extending the length of the building are found the busbars, from which the transformer wires and the lines lead. In this room there are also two large oil tanks which are used in preparing the transformer oil and the oil used in the step bearing.

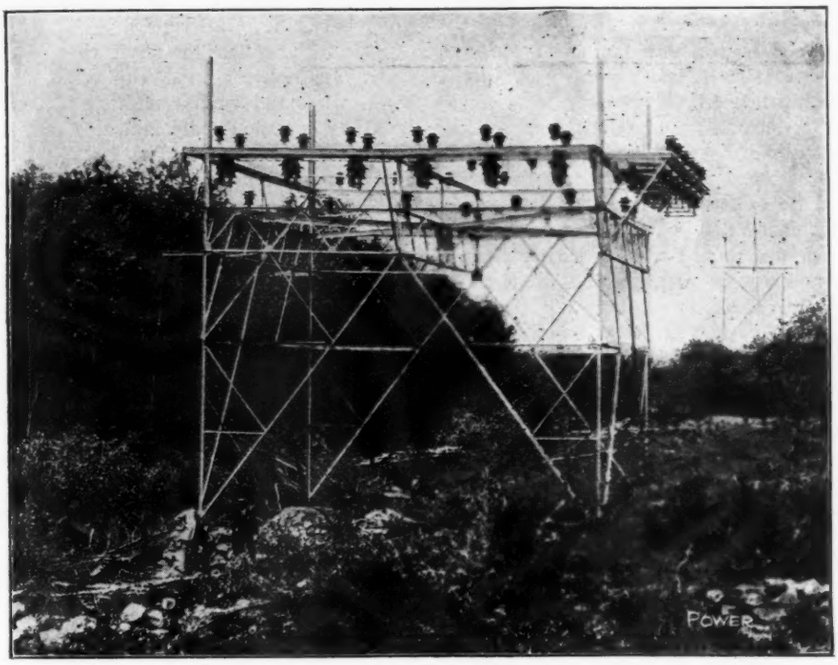

FIG. 6. CONSTRUCTION OF JUNCTION TOWER

TRANSMISSION LINES

On the top of the building are placed three lightning-arrester towers, from which the main transmission lines extend in a southeasterly direction through the towns of Vernon, Hinsdale, Northfield, Warwick, Royalston, Winchendon, Gardner, Fitchburg, Leominster, Sterling, Clinton, West Boylston and Worcester. They consist of two three-phase circuits on steel towers of from 40 to 60 feet in hight, set in concrete, each tower being sufficiently stable to carry its load under all weather conditions, even if all the wires in one span should break.

Each circuit is composed of three-stranded copper conductors of No. 2 Brown & Sharpe gage, about ⅜ inch in diameter, and has a carrying capacity of 10,000 horsepower at 5 per cent. loss. In an emergency, one circuit would carry the entire load, although at somewhat greater loss.

The porcelain insulators are of the pin or vertical type, consisting of four separate parts or shells cemented together, the outside diameter being 15x14 inches in hight and weighing about 35 pounds each. Each insulator has been tested at 180,000 volts.

About every ten miles is placed a junction tower, one of which is shown in Fig. 6, where are located sectionalizing switches for testing purposes. A ground wire of No. 4 copper-clad, steel-core wire is stretched over the entire line and is attached to the apex of the tower above all transmission wires, every tower being permanently grounded to secure protection from lightning. A private telephone line is installed over the entire line, with instruments at each substation and junction tower, where a small house is erected to receive the telephone and a supply of repair material and tools for emergency use.

The total length of the line is over 66 miles and is divided into six sections for purposes of patrol, each man having from 10 to 12 miles to cover on foot twice each week.

As there are 885 towers on the line (exclusive of a branch line) this gives an average spacing of 410 feet between towers, although there are a few larger spans, notably that over the Wachusett reservoir of 1940 feet.

If it is necessary to change or replace an insulator, which work is usually done at night or on Sunday, the entire load is thrown onto one line, the other line is opened at both ends and all three wires are grounded on the tower on which the work is to be done, thus enabling the men to work in perfect safety. The patrolman either disconnects the section of the line at the junction towers or more often telephones the power house and substations that he is about to work on a certain line. Then all the operators place tags on the switches controlling this line and state the time the line is ordered off, the nature of the work to be done and gives the name of the man ordering the line off; no operator will energize this line until the same workman has ordered all the tags removed.

Substations are located at various towns, one of which is shown in part in Fig. 7. From this substation electrical energy is delivered to manufacturing concerns, electric-light companies, etc.

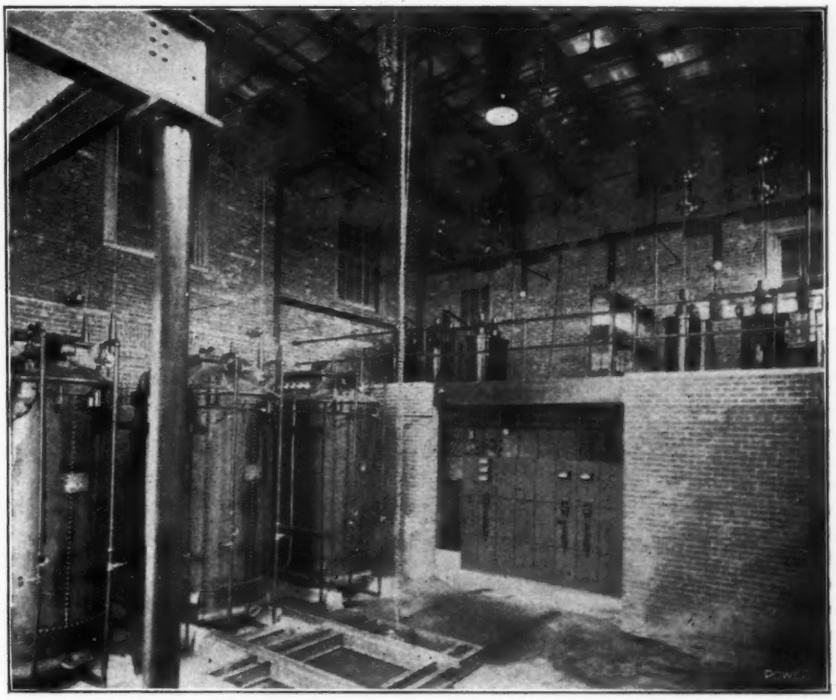

FIG. 7. PARTIAL VIEW OF ONE OF THE SUBSTATIONS

It is the practice of the company to carry feeders to the premises of its customers and require them to install all apparatus for the conversion of the

energy to suit their individual needs. Usually disconnecting switches are installed at the entrance point of each installation and there the company's responsibility ends, except that it provides all metering equipment. Both integrating and graphic wattmeters are installed for each customer, so that from the records the characteristics of each customer's load are known.

Synchronous motors are installed on the system amounting to about 4000 kilowatts in capacity, thus giving an opportunity to correct the power factor on the system. As a matter of fact the average power factor at the Vernon station is about 90 per cent.

Contracts

The flow of the Connecticut river varies with the seasons so that at certain periods there is an abundance of water and less at other times. Therefore two classes of contracts, termed primary and secondary, are made. Primary contracts guarantee to deliver to a customer the amount of power for which he contracts. Under secondary contracts the right to cut off the supply on reasonable notice is reserved, but giving the customer the opportunity of starting his own steam plant and carrying his own load. Naturally, under the secondary contracts electrical energy is sold at a lower price than is charged for primary contracts.

Reciprocal contracts have been made with some of the large customers whose steam plants have been shut down, whereby the plants are held in readiness for operation and the company has the privilege of operating them when necessary, turning energy into its own system. These contracts are advantageous as avoiding the necessity of building an auxiliary steam plant to guard against possible extreme flow in the Connecticut river.

A contract has also been made with the Metropolitan Water and Sewage Board for the output of the hydraulic plant which the board is about to build at Clinton. In this situation the water from the Wachusett reservoir is delivered to the aqueduct leading to the Boston system and additional power can be developed at this point. It is planned to install four 1000-kilowatt generators, three of which will be used normally with the fourth one held in reserve. Inasmuch as this reservoir is usually drawn on in the summer time, the Connecticut River Transmission Company can use this power during the periods when it would naturally experience low water in the Connecticut river.

It is not altogether what is in the coal but what can be got out of it that makes it valuable as a fuel to the power-plant owner.

Hydraulic Hammer Test for Boilers

By J. E. Terman

Most readers of Power are familiar with the hammer test as used in inspecting steam boilers and also with the hydrostatic test for the same purpose, but probably few are acquainted with a combination of the two, or what might be termed a "hydraulic-hammer test" which was once recommended to me as the best and surest method of determining the safety of a boiler. I was at the time inspecting boilers for an insurance company in the South, and after a day's work on a sugar plantation went to its general store to while away the time between supper and bed time, and also for the purpose of getting the owners (who also operated a sawmill) sufficiently interested to consent to insure their sawmill boilers as well as those at the sugar house. The usual crowd of overseers and hangers-on were ranged on soap boxes around the stove in the rear of the store, ready to discuss any subject that might be broached. The sawmill manager was one of the group, and after the presentation of the customary cigar I proceeded to give him the inside facts regarding the numerous advantages to be gained by having his boilers and plant regularly inspected by a mechanic who devoted his entire time and talents to this one class of work. Great pains were taken to describe in detail the thoroughness with which the inspections were made and how the experience gained by the inspector could be obtained in no other way, and that he was thereby enabled to detect defects and dangerous conditions of operation that would ordinarily escape the notice of an engineer.

About the time the sawmill manager was beginning to weaken under the continuous presentation of facts, a bystander (who proved to be the man in charge of one of the skidder outfits used in pulling the logs out of the swamp) entered into the conversation. He said: "Young man, it may be all right to crawl through the biler like you tell about, and lamm its insides with a tack hammer, but I can tell yer that yer are wasting yer time. I never look inside a biler to tell whether it is good to hold steam or not, but I always tests a strange biler my way to be shore that it is all right before I fire her up."

I told him that I was greatly interested in what he said, for there were many inspectors throughout the country wearily dragging themselves through boilers every day in an endeavor to determine whether they were safe to carry pressure or not, and if he could recommend a more effective method that would do away with this laborious feature all inspectors would look on him as a benefactor. "Well, this is the way it is done," he said. "You first fill the biler plumb full of water, clear up to the top, and then yer shut all of the valves tight, and git a sledge hammer (about ten pounds is the right heft) and yer belt the biler a good stiff one on the side, and if she don't bust, she is all right."

I was compelled to admit that if a boiler was entirely filled with water and could withstand such treatment without breaking, it undoubtedly indicated that it possessed staying qualities, at least before taking the treatment, but I was able to thoroughly convince the sawmill manager that his boilers had best be given the hammer test in homeopathic doses with a tack hammer, as my friend described it, and not be belted in the sides with a 10-pound sledge.

Boiler Explosions in England

The following extract from the report of the Committee of Management of the Manchester Steam Users' Association in England is of interest, as it shows what may be done by careful and rigid inspection toward reducing the number of boiler explosions and the resulting fatalities:

"As many as 22,656 examinations were made of boilers during 1910, including feed-water heaters or fuel economizers, 9675 of these being 'internal,' 'flue' and 'entire' examinations, the highest number ever yet recorded.

"The firebox of a locomotive crane boiler enrolled with the association had collapsed and rent during the year, resulting in personal injury to several workmen. The matter, the report stated, was still under investigation, with a view to determining the actual cause, which could not at present be stated. At the end of 56 years' working the committee was able to report that no life has ever been lost by the explosion of any boiler under the association's guarantee.

"Outside its ranks the association had recorded, during the year 1910, the occurrence of 85 explosions, killing 20 persons and injuring 71 others. Of these, 24, killing 9 persons and injuring 34 others, may be termed 'boiler explosions proper,' while the remaining 61, killing 11 persons and injuring 49 others, may be termed 'miscellaneous explosions'—those arising from steam pipes, stop valves, kiers, drying cylinders, bakers' ovens, etc. In addition to the above, one explosion arose from the bursting of a kitchen boiler, by which one person was killed. These figures are higher than for several years past, but in many cases the explosions were of a comparatively trifling character, though subject to investigation under the provisions of the Boiler Explosions acts, 1882 and 1890."

A record of 56 years without a single fatality from boiler explosions is indeed remarkable. Just imagine the opportunities presented to a similar association in this country.

Notes on the Design of a Drip System

By J. P. Lisk

The drip system as now installed in a certain high-pressure steam plant is described and its defects are pointed out. A revised arrangement of drips is also submitted, in which the existing defects are eliminated.

The design of a piping system for a modern steam-power plant requires a thorough knowledge of working conditions obtained by actual experience in erecting and operating the various apparatus of which a plant is composed. It is also necessary that practical experience be supplemented with a comprehensive knowledge of mathematics, physics and applied mechanics in order to obtain the best possible results, viewed from the standpoint of safety, economy of operation and durability.

Attention to the design of the drip system of a plant has a more direct bearing on the safety of operation than all of the safety devices on the market. Yet the safety devices are usually applied to the drip end of some apparatus, and their operation is contingent on the arrangement and capacity of their discharge pipes. Most engineers will agree that a large percentage of the troubles is caused by inadequate or improperly arranged drip pipes.

There are many cases where the trunk line is too small, and when one trap is discharging it blocks off all the rest of the drip lines; also, when certain bypasses are opened, high-pressure steam gets into the low-pressure lines, causing water to block up into places where it is quite likely to do severe damage. The writer knows of three plants in which the high-pressure steam drips were inadvertently bypassed into the low-pressure lines. One of these resulted in a 2400-horsepower cross-compound engine having its frame broken just in front of the guides, the crank pin sheared and the main rod twisted. Another 80-horsepower Corliss had its reciprocating parts wrecked, and in the third instance the entire engine room was put out of commission and four men were seriously injured. The arrangement that was made, and the one that should have been made under the existing conditions, in connecting up a high-speed Corliss engine is shown in the accompanying illustrations. These are sectional elevations through a portion of the engine room of a recent installation, according to the plans and specifications of an expert consulting engineer.

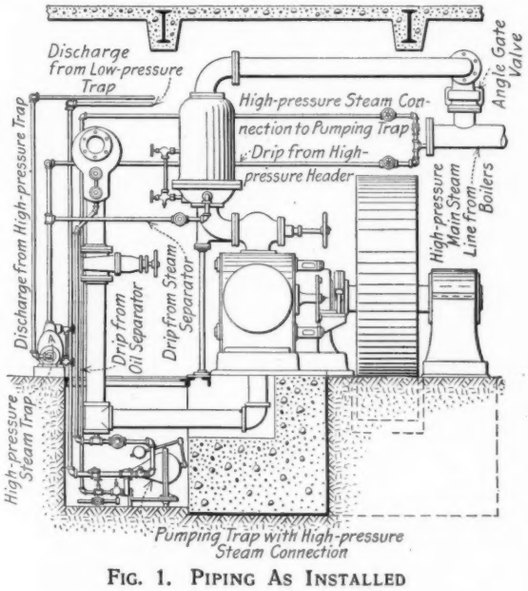
Discharge from Low-pressure Trap
Angle Gate Valve
High-pressure Steam Connection to Pumping Trap
Drip from High-pressure Header
Discharge from High-pressure Trap
High-pressure Main Steam Line from Boilers
Drip from Oil Separator
Drip from Steam Separator
High-pressure Steam Trap
Pumping Trap with High-pressure Steam Connection

FIG. 1. PIPING AS INSTALLED

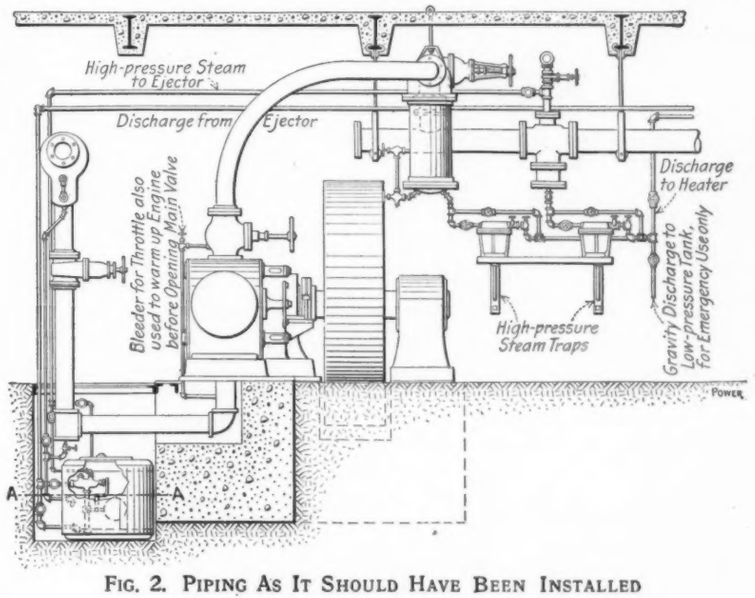
High-pressure Steam to Ejector
Discharge from Ejector
Discharge to Heater
Bleeder for Throttle also used to warm up Engine before Opening Main Valve
High-pressure Steam Traps
Gravity Discharge to Low-pressure Tank for Emergency Use only
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FIG. 2. PIPING AS IT SHOULD HAVE BEEN INSTALLED

Fig. 1 shows the plant as it was installed. The engine is an 18x30-inch Corliss, running at 150 revolutions per minute and driving a 205-kilowatt generator. Steam is supplied at 100 pounds pressure by horizontal tubular boilers located approximately 160 feet from the end of the header, shown at the right side of the drawing. There is a decided objection to the manner in which the 6-inch steam connection is run to the engine; a long-necked angle gate valve is bolted rigidly to a nozzle welded to an 8-inch pipe; from the top outlet there is a 6-inch extra-heavy 90-degree pipe bend with extra-heavy fittings leading to a vertical receiver-type steam separator which is joined in the most rigid manner possible to the throttle valve. A more flexible-proof, strain-producing arrangement would be hard to devise. Angle valves should never be used in this or similar positions. They are not looked upon by the manufacturers as unqualifiedly successful in high-pressure steam work in sizes larger than 3 inches in diameter.

Fig. 2 is a much better arrangement for the same connection. Starting from the 6-inch outlet on the header with a pair of flanges having a nipple between to make a swing joint, a long-radius ell is added, and to this is attached a straightway valve, immediately following which is a horizontal steam separator. From the outlet of the separator there is a compound bend to the top of the throttle valve, which makes the second swing joint in the flange on top of the valve. The entire connection would be as flexible as it is possible to make it and be steam tight.

In the system as laid out in Fig. 1, the only drip from the 160 feet of supply main is the 1¼-inch pipe running to the high-pressure steam trap located as shown at the left of the engine. This also takes the drip from the steam separator, and from the heel of a 2½-inch high-pressure line running to a remote part of the building to supply steam to a type foundry. The steam supply to operate the pumping trap shown in the pit is also taken from the same 1¼-inch outlet. This arrangement brings all the water of condensation from the 160 feet of 8-inch pipe, equivalent to 329.6 square feet of condensing surface, to a point directly under the 6-inch branch to the engine, where there occurs a right-angled

change in the direction of the current of steam flowing at a high velocity. This results in a large portion of the water which should be taken care of by the drip line being broken up into spray and carried to the separator. As a result, the separator is greatly overloaded, its efficiency is reduced and a large amount of water reaches the engine. This water by actual test amounts to 138 pounds per hour.

Disregarding the resulting operating difficulties, the question may be asked: "Where is there any loss?" The condensation will take place in the long steam line just the same, regardless of the drip arrangements. To a certain extent this is true, but in the one case clean water is carried back to the boiler at a high temperature, and in the other the oily water must be thrown away. When the feed water comes through a meter and the price of coal is high, 138 pounds of boiling water per hour going to the sewer will amount to an appreciable item for each month of operation.

While the drip piping of this plant is bad on the steam side, it is still worse on the exhaust side of the engine. Referring to Fig. 1, the exhaust pipe drops from the exhaust outlet about 20 inches, then crosses over to a tee at the foot of the riser, which extends upward about 9 feet and then runs horizontally about 18 feet to the main 12-inch exhaust line. There is a gate valve in the riser, and an oil separator in the top horizontal run, about 4 feet from the ell on the vertical line. From the bottom of the tee on the riser there is a 1¼-inch nipple with a bull-head tee, one side of which receives the drip from the oil separator, the other being connected to the receiving side of a high-pressure return trap. The discharge from the trap is carried up to a point over the horizontal exhaust line and thence to the sump, 110 feet from the trap pit. The pit being 4 feet lower than the sewer, there is no chance to get rid of waste water except by the use of a hand pump and bucket. Unfortunately, the excavation for the engine foundation was not waterproofed, and some water veins, that gave considerable trouble when the building was constructed, have found an outlet into the wheel and trap pits. It is now necessary for the engineer to give close attention to these places and see that water does not accumulate in a sufficient quantity to destroy the main belt or put the trap out of commission.

An especially bad feature of the drip system is that of placing a return trap in the position shown, as the only means of taking care of the drips on the exhaust side of a high-speed engine. The trap itself is all right in the work for which it was designed, but in this case it is entirely out of place, being required to handle the oil discharged from the oil separator as well as the drip water from the engine. Furthermore, failure to operate is apt to be accompanied by a wrecked engine with possible injury to the attendants. Engine builders, as a rule, object to a trap of any kind between the exhaust side of their engines and the atmosphere. The writer has never known of an instance where the builder would turn a new engine over with a trap-closed drip until someone in authority would assume all responsibility for any damage that might directly or indirectly result from its being so connected.

Now for a short study of the piping as arranged in Fig. 2. The manner of making the 6-inch steam connection with the swing joints has been already referred to. About four feet from where the engine branch rises to the separator a drip leg has been inserted and connected to a trap so that all of the condensation taking place in the main may be returned to the receiving tank and heater without the possibility of a large portion of it having to pass through the steam separator. The main has also been extended 30 inches beyond the engine branch in order to obtain a cushion effect to help lessen the vibration induced by the pulsations of the steam passing to the engine.

The high-pressure drip system for the water leg and the separator are entirely independent of each other up to the trunk-line discharge pipe, and that is arranged to deliver to the return tank or, in an emergency, to the sewer. Another feature worth passing notice is that all water which gathers in the main when the engine is out of service and the stop valves on the boilers are closed, may be removed by gravity. The high-pressure line to operate the ejector and drip tank is taken from the top outlet of the cross above the drip leg, and in such a way that there is no possibility of any water being carried over to interfere with the proper operation of that apparatus.

The manner in which the drip water from the exhaust pipe and oil separator is handled is, under the conditions, all that could be desired when viewed from the standpoint of efficiency, economy and safety. The sump tank is 36 inches in diameter by 36 inches high, made of 5/16-inch steel plates, and in the top head there is a 20-inch opening, fitted with a cover securely bolted on. In this cover directly over the operating end of the ejector is a hole tapped for a 3½-inch pipe and closed with a brass plug, which may be readily removed and a drop light let down into the tank for inspection.

When it becomes necessary to make repairs to the mechanism of the ejector, which does not happen very often, the cover may be removed and replaced again with but very little work and with the ordinary tools found in every engine room. Within the tank there is a steam-operated ejector, the valve of which is operated by a float. The tank is so piped that all of the drip water from the engine exhaust and from the oil separator flows into it by gravity. When a certain level, indicated by *A A*, is reached the float turns on the steam valve of the ejector and the water is forced out of the drip tank into the blowoff tank, which is located at a higher level, and thence to the sewer. When the water reaches the lowest point at which the ejector is set, the float closes the steam valve and the ejector ceases to work until the high level is again reached.

The ejector, as shown, is within the tank; high-pressure steam is brought from the main header to the ejector, passing through the shell of the tank and having a union between the ejector and the shell, all made steam tight so that the high-pressure steam may not escape to the tank through this connection. There is also a branch from this high-pressure line connecting directly with the tank. Each branch has a controlling valve so that high-pressure steam may be supplied to the ejector or to the tank as desired. From the bottom of the tee in the main exhaust pipe and from the drip outlet of the oil separator a drip pipe is carried through the shell of the tank and then turns down. This arrangement allows all of the oil coming to the tank to drip free of the piping and also get to the surface of the water without having to be forced through it.

In addition to the automatic operation of the tank it may be worked by hand in an emergency in the following manner: When the tank is nearly filled (which condition may be determined by a try cock) the valves in the drip pipe from the separator and the exhaust loop are closed, as is also the direct discharge from the ejector. The valve in the discharge branch from the bottom of the tank is then opened first, after which the valve in the high-pressure connection at the top is opened. The contents of the tank will immediately be driven through the discharge pipe to the blowoff tank. After the tank has been emptied, which will probably require about two minutes, the valves are readjusted for the regular service.

As before mentioned, the amount of water passing through the trap under present operating conditions is 138 pounds per hour, which would be very much decreased with the system shown in Fig. 2. The periods for emptying the tank, which at three-quarters full and at a temperature of 200 degrees contains 954 pounds, would be 6.9 hours. When the tank is blown out in the manner mentioned, any accumulation of oil, or any other foreign matter contained in the drip water is also removed. It is a good plan, under normal conditions, to blow down once a month at least in order to keep the entire drip system clean and in as good working order as possible.

Temperature Conversion Chart

By Le Roy W. Allison

A chart showing the relation between the three temperature scales, namely, the Fahrenheit, the Centigrade and the Reaumur. By its use any one of the six conversions between these scales is readily obtained.

The accompanying diagram offers a convenient means of conversion between the three temperature scales in use and from which six transpositions are derived. In electrical work frequent use is made of the Centigrade scale, and conversion into degrees Fahrenheit is frequently necessary for reference and recording purposes.

The Centigrade thermometer is employed wherever the metric system is in use and, owing to its simpler form of graduations, its application is greater in extent than the Fahrenheit scale. It establishes the freezing point at 0 degrees and the boiling point at 100 degrees, making the divisions thereby obtained exactly 100, corresponding to 180 on the Fahrenheit scale, which places the two extremes at 32 and 212 degrees respectively.

The Reaumur is commonly referred to as the German scale and is the standard in a few countries; in America its greatest use is possibly for such work as distilling and brewing. It represents the freezing point at 0 degrees and the boiling at 80 degrees.

The conversion chart is obtained from the usual formulas giving the relations between the three scales, and from the respective boiling points the existing ratios are derived. Representing temperature Fahrenheit by F, temperature Centigrade by C, and temperature Reaumur by R,

$$\textit{One degree } C = \frac{180}{100} = \frac{9}{5} \textit{ degrees } F$$

$$\textit{One degree } R = \frac{180}{80} = \frac{9}{4} \textit{ degrees } F$$

$$\textit{One degree } R = \frac{100}{80} = \frac{4}{5} \textit{ degrees } C$$

The formulas for conversion are:

$$F = \frac{9}{5}C + 32 \qquad (1)$$

$$F = \frac{9}{4}R + 32 \qquad (2)$$

$$C = (F - 32)\frac{5}{9} \qquad (3)$$

$$C = \frac{5}{4}R \qquad (4)$$

$$R = (F - 32)\frac{4}{9} \qquad (5)$$

$$R = \frac{4}{5}C \qquad (6)$$

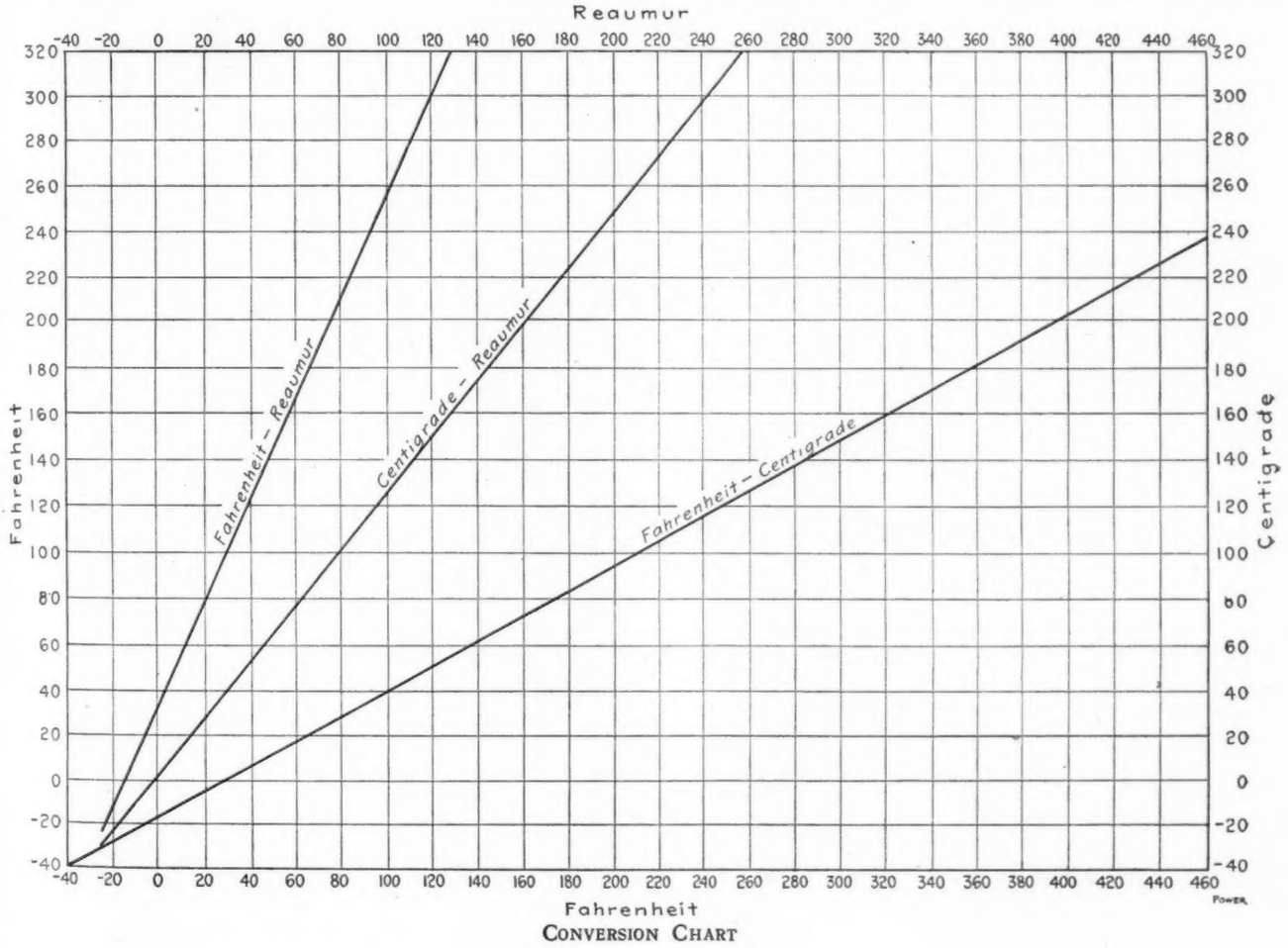
The three curves of the diagram cover the six conversions in a range suitable for ordinary use and capable of any extension. A practical example will illustrate the application.

Assume that a generator guarantee gives a full rated load with a rise in temperature not exceeding 40 degrees Centigrade and degrees Fahrenheit are desired.

By formula (1)

$$F = \frac{9}{5} \times 40 + 32 = 104 \textit{ degrees}$$

Referring to the chart, the known Centigrade temperature is found at the



CONVERSION CHART

right-hand scale, the intersection of the abscissa marked 40 with that of the line marked Fahrenheit-Centigrade gives the corresponding Fahrenheit-degrees temperature, the reading being obtained from the divisions at the bottom, marked 104.

The left-hand scale marked Fahrenheit is used when conversion to Fahrenheit from Reaumur or *vice versa* is required, and is applied in conjunction with divisions along the top marked Reaumur.

The diagram as shown is easily plotted and may be mounted on cardboard or otherwise for handling and preservation.

Cylinder Oil Consumption Tests

By W. T. Heck

The engineering laboratory of Purdue University has two engines which are used for experimental purposes only, one being a noncondensing 7¾x15-inch Buckeye, the other a noncondensing 7x12-inch straight line. The Buckeye has a piston valve, the straight line a gridiron valve. Prony brakes are used for absorbing and measuring the power developed; the cylinders are tapped for indicators, and the speed is controlled by flywheel governors acting upon the valve adjustment.

Tests were made upon each engine running at approximately full load with a steam pressure maintained constant at 125 pounds. The brake load was held constant and readings of speed, steam pressure, brake load, drops of oil per minute and indicator cards were taken at five-minute intervals for a half-hour test. Six tests were made on two afternoons, the engines not being used for any other purpose in the meantime. On the first day the tests were made using respectively three drops, five drops and one drop per minute through sight-feed lubricators. The laboratory temperature was about 88 degrees Fahrenheit and while the amount of oil used in pints was not measured, an idea of the quantity is obtained when the number of drops, make of lubricator and temperature of engine room are known. On the second day, after finding from the previous tests that no difference in frictional horsepower appeared, three tests were made as before, using respectively one drop in two minutes, one drop in three minutes and no oil whatever.

Before the first test on each afternoon the engine was warmed up at full load under test conditions for a half-hour, and between the tests it was allowed to run 10 minutes under the changed conditions before readings for the succeeding test were taken. All operating conditions were maintained constant on the various tests, the only change being the feed of the lubricator. All bearings were kept well oiled on all tests by sight-feed cups that no variations might occur in that part of the engine friction. The steam used in the laboratory is usually of about 98 per cent. quality and it may be considered as practically dry steam after passing the separators of the two engines.

The results obtained are as shown in the tables.

The cylinder oil used in these tests is purchased at 28½ cents a gallon in barrel lots.

The tests might be said to be too short, and that a half-hour is not sufficient time to allow conditions of cylinder lubrication to change. However true this may be, it is believed that the general conclusion from the six tests is not affected.

The results obtained show some variations in engine friction that are unexplainable except that the brake load was not held as constant as it was supposed to be held. Even considering these cases of variation it is plain that the value for frictional horsepower is practically constant for all amounts of cylinder oil fed to the engine.

On the first day the results may have been somewhat mixed because of feeding first three drops, then five and lastly one drop of oil per minute, but the engines were shut down after running 40 minutes on one drop of oil per minute and were started the next day on one drop in two minutes, and the feed decreased to no oil at all on the last test. If any effect were to appear it ought to show on the second day's run, but as it did not, the general conclusion is that the friction from the piston and valves must be a small part of the total engine friction; that the amount of oil fed to the cylinder and valve does not affect the total engine friction appreciably; therefore it is best to use as little oil as possible, so long as the valves do not groan and creak. Another natural conclusion is that too much oil is commonly used on small high-speed engines.

It was customary to use three drops of oil per minute on these engines heretofore. An Atlas 10x16-inch engine carrying the shop load has had its oil supply reduced as a result of the above tests and no effect upon its operation has been noticed.

This matter must be left finally to the judgment of the engineer, but it should be remembered that sufficient oil is enough; any more is waste.

The foregoing tests were conducted by seven senior students in mechanical engineering under the direction of an instructor.

FRICTION TEST OF BUCKEYE ENGINE

	5 drops per min.	3 drops per min.	1 drop per min.	1 drop in 2 min.	1 drop in 3 min.	no oil
Quantity of oil						
Temperature of engine room, degrees F.	88	88	88	88	88	88
Date of test	2–28–10	2–28–10	2–28–10	3–2–10	3–2–10	3–2–10
Speed of engine, r.p.m.	215	215	215	215	215	215
Steam pressure, pounds gage	125	125	125	125	125	125
Indicated horsepower	44.68	44.98	46.15	45.15	44.80	45.56
Brake horsepower	39.4	39.4	39.4	39.4	39.4	39.4
Frictional horsepower	5.28	5.58	6.75	5.75	5.40	6.16

FRICTION TEST OF STRAIGHT-LINE ENGINE

	5 drops per min.	3 drops per min.	1 drop per min.	1 drop in 2 min.	1 drop in 3 min.	no oil
Quantity of oil						
Date of test	2–28–10	2–28–10	2–28–10	3–2–10	3–2–10	3–2–10
Temperature of engine room, degrees F.	88	88	88	88	88	88
Speed of engine, r.p.m.	270	270	270	272	272	272
Steam pressure, pounds gage	125	125	125	125	125	125
Indicated horsepower	22.12	22.44	21.39	21.76	21.93	21.41
Brake horsepower	19.53	19.53	19.53	19.53	19.53	19.53
Frictional horsepower	2.59	2.91	1.86	2.23	2.40	1.88

Preventing Gas Explosions in Boiler Uptake

In a certain power plant the chief engineer after much trouble and experimenting discovered a way to prevent the gas explosions which occurred in the smoke uptakes of his boilers and at the same time to obtain better combustion than he had been getting from the grade of fuel used.

His method of firing the boilers is to allow the furnace doors to remain open about one inch at all times. No. 2 buckwheat and a 15 per cent. mixture of anthracite are used, the combination producing an average of 18 per cent. ash.

The stack has a natural draft of 1⅝ inches. A forced-draft fan is used to furnish air under the grates, the draft being ⅞ inch.

After it was discovered that leaving the doors of the furnace open prevented these gas explosions, the engineer came to the following conclusion: Inasmuch as the coal was fine and packed closely together when thrown upon the grates, it was natural that the firemen should throw in too much coal at a firing and as a consequence insufficient air would be forced up through the fuel which resulted in incomplete combustion of the gases. At times so much gas escaped from the furnace without becoming ignited that it would reach the uptake before ignition took place, when, of course, an explosion occurred. Admitting an additional amount of air over the grates prevented the trouble.

Automatic Step Bearing Pump

An auxiliary pump which is electrically controlled and is automatically started and stopped between predetermined limits of pressure on the step bearing.

Most engineers are familiar with the method of floating the rotating element of a steam turbine, and know the construction of the step bearing and the method employed to maintain the oil pressure.

At the power plant of the Lynn Gas and Electric Company, Lynn, Mass., water is used in the step bearing, instead of oil, a steady pressure being maintained, as is usual, by means of an accumulator. An auxiliary automatic pumping unit was installed in order to guard against any possible accident to the turbine. The unit is automatically cut into operation when the pressure drops to 375 pounds, a pressure of 400 pounds per square inch being the maximum.

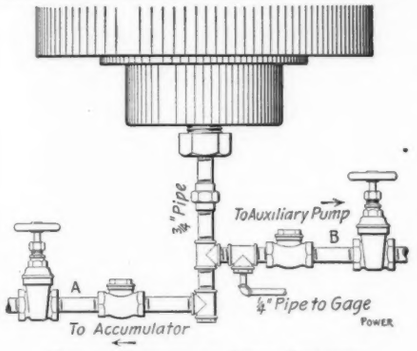


FIG. 1. PIPING TO STEP BEARING

Fig. 1 shows a partial view of the step bearing and the pipe connections. The bottom ¾-inch pipe leads to the accumulator and is fitted with a check valve which remains open just so long as the pressure in the step bearing remains normal. The check valve in the upper pipe, which leads to the auxiliary pump, remains closed so long as the water pressure in the accumulator continues normal. If there should be any trouble in the accumulator, or the pipe leading from it to the step bearing, the check valve in pipe *A* will close, due to a reduced pressure, and the check valve in pipe *B* will open, due to a pressure which is maintained by the auxiliary pump, which is automatically started, either by the accumulator dropping a predetermined distance below normal of about five inches, or to the reduced pressure in the pilot pipe leading to the automatic apparatus.

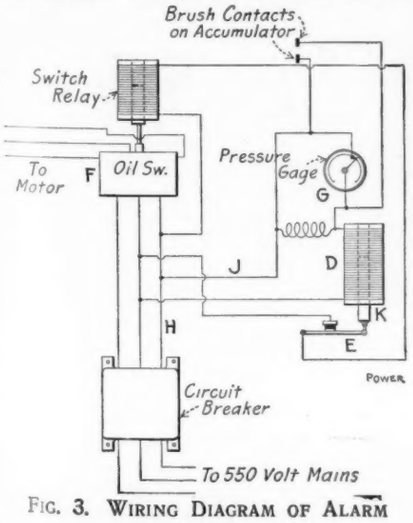


FIG. 3. WIRING DIAGRAM OF ALARM SYSTEM

On the bottom of the accumulator there is attached an arm to which is connected an ordinary brushholder containing carbon brushes. Attached to a post that extends from the basement ceiling to the cement floor of the basement are four contact blocks arranged as shown in Fig. 2. The upper contacts are connected by wires to an electric bell. The lower contacts are connected with a coil which closes the circuit through the coil *D*, shown in Fig. 3, the operation of which will be explained later. As the accumulator drops below a predetermined point the carbon contacts form a circuit through the two upper contact pieces, which causes a bell to ring in the turbine room, thus calling the engineer's attention to the fact that the accumulator is floating at a low level. If the accumulator still continues to drop, the circuit is closed through the two lower contacts, causing a current to flow through the coil *D*, Fig. 3, which closes the switch *F*, and thus operates the oil switch on the motor circuit.

Fig. 3 shows a diagrammatic view of the controlling apparatus, and Fig. 4 shows a general view of it. The operation of this apparatus is as follows: The pressure gage *G* is connected by the pilot pipe with the step bearing of the turbine. This pressure gage is fitted with a pointer and an adjustable contact fitted to a brass ring on the dial of the gage. The contact is made adjustable in order that the point of contact between it and the finger may be regulated at will.

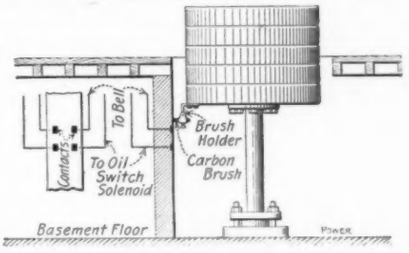


FIG. 2. ACCUMULATOR ALARM SYSTEM

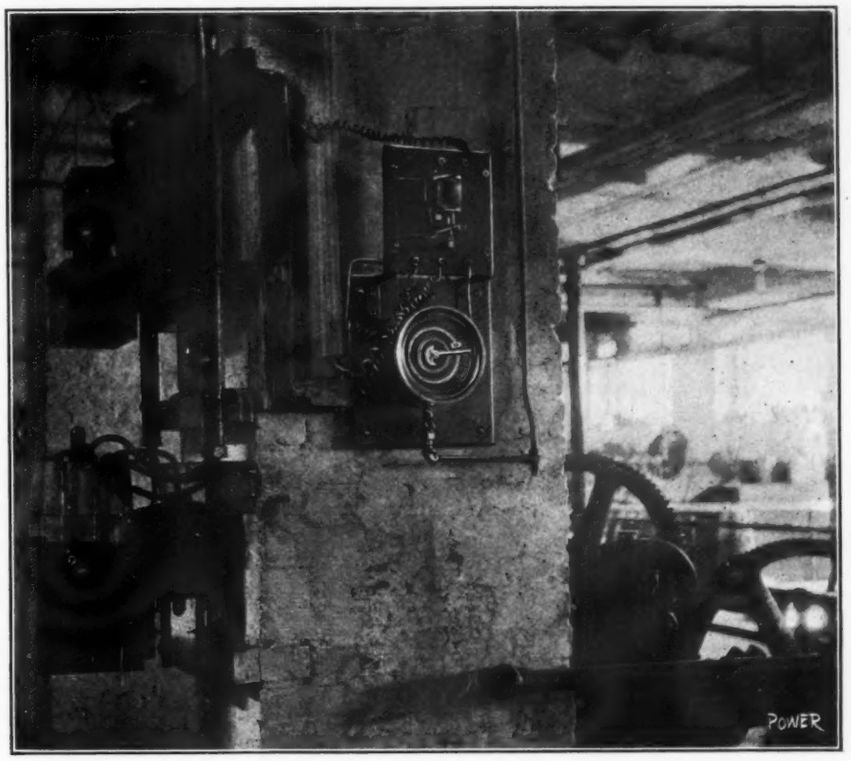


FIG. 4. GENERAL VIEW OF THE CONTROLLING APPARATUS

In case an accident should happen to the piping between the accumulator and the step bearing, the pressure would be reduced in both the pipe and in the pilot pipe, which allows the gage finger to move backward until it comes in contact with the brass contact piece which forms a circuit from the main feed line H through the wire J and coil D. This magnetizes the coil and draws the plunger K up into it, thereby closing the switch E.

Referring to Fig. 3 again, it will be seen that there is a low-resistance coil between the two wires as shown. This resistance is of such strength and the plunger K is so delicately balanced that once it is drawn up into the coil the current passing through the shunt and coil is just strong enough to hold it suspended; the closing of the circuit through the pressure gage is for the purpose of supplying an extra amount of current momentarily to the coil D.

When the switch E is closed, a current passes in the proper direction through the solenoid coil of the oil switch to draw the plunger up, closes the switch and permits a 550-volt current to pass through the circuit-breaker to the motor of the pump.

The relay coil is in series with the resistance coil and when the pointer is in contact, it cuts out the resistance and allows the current to draw the plunger up into the coil.

The pump motor is of five horsepower capacity, and is of the three-phase squirrel-cage type, and is geared to a Deane three-plunger power pump.

Loss of Head in Pipes

By J. E. Poché

The loss of head due to the resisting friction of the interior surface of a pipe is comparatively large, so that the discharge is only a small percentage of that due to the head. The friction factor for three different small pipes of approximately the same size was obtained in a test, and the results and method of performing the experiment are here given.

The pipes tested were of wrought iron, galvanized iron and brass, respectively. They were laid horizontally in a straight line so that no other losses except that of friction could occur. The area of the cross-section of each pipe was accurately ascertained by filling a known length of the pipe and then measuring its cubic contents. A differential mercury gage was used to measure the loss of head in each pipe between two points exactly 30 feet apart. A valve was placed at each end of the pipes, so as to change the difference of head between those two points.

The discharge per second was ascertained by making the water run into a tank placed on a scale; and the time for a convenient number of pounds to flow was taken by means of a stop watch. The temperature of the water was taken so that the weight per cubic foot could be found from a table. This discharge in cubic feet per second is

$$Q = \frac{w}{t \times W}$$

in which w is the number of pounds of water discharged into the tank, t is the time in seconds for this water to flow, and W is the weight of this water per cubic foot as taken from the table.

The velocity of the water in the pipe in feet per second was calculated by means of the formula

$$Q = a\,v, \text{ or } v = \frac{Q}{a}$$

in which a is the cross-sectional area of the pipe in square feet. The loss of

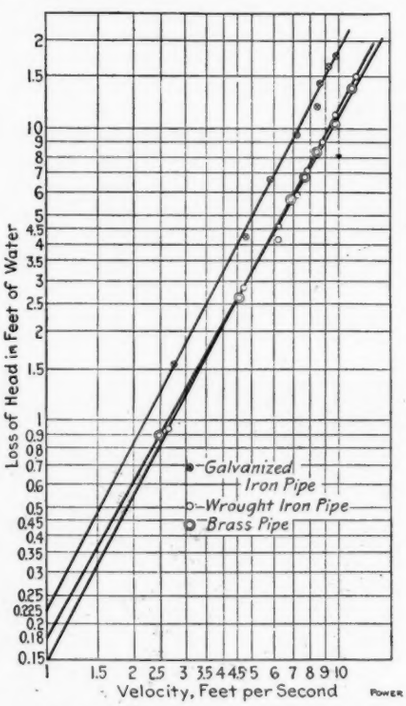


Chart Showing Loss of Head

head in friction is proportional to the length of the pipe, increasing with the roughness of the interior surface and decreasing as the diameter of the pipe increases; it increases nearly as the square of the velocity and it is independent of the pressure of the water. Therefore we can write the formula

$$h' = f\frac{l}{d} \times \frac{v^2}{2g}$$

in which h' is the loss of head in feet, l is the length of the pipe—30 feet in this case—d' is the diameter of the pipe in feet, and $\frac{v}{2g}$ is the velocity head due to the mean velocity of flow. As all these values can be measured except the coefficient of friction f, we solve for f and get

$$f = \frac{2\,d'gh'}{v^2 l}$$

The values shown in the accompanying table were obtained in the same way for each of the three pipes. The water was turned on, the gage being properly connected up, and the valve at the top of the gage was opened to allow all the air to escape. The valves at the ends of the pipe were manipulated so as to get the greatest value for the difference of head $(H_1 - H_2)$, and the time for 400 pounds of water to flow was taken. A running start was made every time; readings of the gage were taken several times at short intervals during the run. The table shows the mean of these readings. The value of $H_1 - H_2$ was then reduced by steps to nearly zero, readings being taken at each step.

Assuming the values obtained during test No. 3 for the wrought-iron pipe and substituting in the above formulas, we get:

$$Q = \frac{w}{t\,W} = \frac{400}{119.4 \times 62.28} = 0.0538 \text{ cu.ft. per second}$$

$$v = \frac{Q}{a} = \frac{4Q}{\pi d^2} = \frac{4 \times 0.0538}{3.14 \times (0.088)^2} = 8.85 \text{ feet per second}$$

$$H_1 - H_2 = 12.6\ (2.57 - 1.855) = 9 \text{ feet}$$

$$f = \frac{2\,d'gh'}{v^2 l} = \frac{2 \times 0.088 \times 32.2 \times 9}{(8.85)^2 \times 30} = 0.0217$$

It is seen from the table that the values for f increase in nearly every case as the velocity decreases, as would be expected. It is also observed that the loss of head is greatest for the galvanized pipe and least for the brass pipe.

If a curve is plotted on logarithmic cross-section paper between the loss of head in feet of water and the velocity in feet per second for the values found for the three pipes, we will get three straight-line curves as shown. The value of C, a constant for each pipe, in the equation

$$H_f = C\,v^n$$

can be found directly by prolonging each curve until it crosses the axis of coördinates. It remains now to find the value of n in the above formula.

When $v = 1$, $\log. v = 0$ and $\log. C = \log. H_f$, or $C = H_f$, as can be seen from the curves.

$$\log. H_f = n \log. v + \log. C$$

For the wrought-iron pipe, $C = 0.15$. Taking $v = 4$, then $H_f = 2.05$ and

$$\log. 2.05 = n \log. 4 + \log. 0.15$$

$$0.313 = n \times 0.603 + (9.177 - 10)$$

whence,

$$n = \frac{1.136}{0.313} = 1.885$$

For the galvanized-iron pipe $C = 0.225$. Taking $v = 5$, then $H_f = 4.75$ and

$$\log. 4.75 = n \log. 5 + \log. 0.225$$

$$0.677 = n \times 0.699 + (9.352 - 10)$$

whence,

$$n = \frac{1.325}{0.699} = 1.9$$

For the brass pipe $C = 0.18$. Taking $v = 8$, then $Hf = 7.15$ and

$$log.\ 7.15 = n\ log.\ 8 + log.\ 0.18$$

$$0.855 = n \times 0.904 + (9.256 - 10)$$

whence,

$$n = \frac{1.599}{0.904} = 1.77$$

From these calculations it is seen that the value of n is very nearly 2, which proves the statement made above to the effect that the loss of head increases "nearly" as the square of the velocity. Other values can be assumed for v and the corresponding values of Hf taken from the curve and thus other values for n can be found. But in each case they will be very close to those calculated above.

LOSS OF HEAD IN PIPES

Number	Time for 400 Lb. to Flow, Seconds	Cubic Feet per Second	Velocity, Feet per Second	Coefficient of Friction $f = \frac{H}{v^2} \cdot \frac{2dg}{l}$	Gage Readings H_1 Ft. Hg.	Gage Readings H_2 Ft. Hg.	Gage Readings Diff. $H_1 - H_2$	Loss of Head Feet of Water $12.6\ (H_1 - H_2)$	Constants
				WROUGHT-IRON PIPE					
1	91.4	0.0705	11.59	0.0212	2.805	1.610	1.195	15.05	Temp. of water = 75° F. Diam. of pipe = 0.088 ft. Area of pipe = 0.00608 sq.ft. Length of pipe = 30 ft. $\frac{29d}{l} = 0.189$
2	107.4	0.0599	9.85	0.0215	2.645	1.770	0.875	11.01	
3	119.4	0.0538	8.85	0.0217	2.570	1.855	0.715	9.00	
4	135.2	0.0475	7.82	0.0222	2.495	1.925	0.570	7.18	
5	153.2	0.0419	6.89	0.0225	2.437	1.990	0.447	5.64	
6	169.8	0.0378	6.24	0.0221	2.398	2.030	0.368	4.14	
7	221.4	0.0290	4.77	0.0236	2.328	2.102	0.226	2.84	
8	397.8	0.0161	2.65	0.0255	2.253	2.178	0.075	0.945	
				GALVANIZED-IRON PIPE					
1	103.0	0.0624	9.92	0.0347	2.920	1.51	1.410	17.75	Temp. of water = 75° F. Diam. of pipe = 0.0895 ft. Area of pipe = 0.00629 sq.ft. Length of pipe = 30 ft. $\frac{29d}{l} = 0.192$
2	108.8	0.0590	9.39	0.0356	2.855	1.56	1.295	16.30	
3	117.0	0.0549	8.74	0.0362	2.780	1.64	1.140	14.36	
4	125.0	0.0514	8.45	0.0321	2.685	1.74	0.945	11.90	
5	141.5	0.0454	7.23	0.0349	2.605	1.85	0.755	9.50	
6	174.2	0.0369	5.87	0.0372	2.475	1.95	0.525	6.66	
7	210.9	0.0304	4.84	0.0346	2.385	2.05	0.335	4.22	
8	372.6	0.0172	2.74	0.0388	2.280	2.16	0.120	1.51	
				BRASS PIPE					
1	92.4	0.0695	11.29	0.0202	2.750	1.675	1.075	13.55	Temp. of water = 75° F. Diam. of pipe = 0.0885 ft. Area of pipe = 0.00615 sq.ft. Length of pipe = 30 ft. $\frac{29d}{l} = 0.19$
2	106.8	0.0601	9.76	0.0206	2.620	1.800	0.820	10.34	
3	123.4	0.0520	8.44	0.0222	2.540	1.880	0.660	8.31	
4	135.0	0.0476	7.73	0.0217	2.485	1.945	0.540	6.80	
5	145.6	0.0441	7.16	0.0217	2.445	1.980	0.465	5.85	
6	168.8	0.0382	6.21	0.0229	2.400	2.035	0.365	4.60	
7	228.0	0.0281	4.56	0.0242	2.320	2.110	0.210	2.64	
8	420.0	0.0152	2.48	0.0272	2.255	2.185	0.070	0.88	

The majority of boiler explosions occur not while the boiler is in regular service but while it is being started up, particularly if the boiler is being limbered up after a period of idleness. One point may be noted. When a boiler has been standing cold for some time the steam gage is more likely to become stuck than at other times, and the spring may not throw the needle accurately. To guard against the danger which comes where the needle sticks, it is advised that whenever a plant has but one boiler that boiler should have two steam gages. Then if one happens to stick the chances are very small indeed that the other will register wrong also.

Fuller's Earth as an Oil Filter

"The Production of Fuller's Earth," by Jefferson Middleton, of the United States Geological Survey, has just been published as an advance chapter from "Mineral Resources of the United States, 1910."

The fuller's earth resources of the United States, says Mr. Middleton, have attracted considerable attention for several years because of the increasing demand for this material for use as a clarifying agent for mineral and vegetable oils. The original use from which it derives its name, the fulling of cloth, is now of minor importance.

For a great many years fuller's earth, was imported from England, the only known source of supply, but in 1893 it was by accident discovered in this country. At Quincy, Fla., an effort was made, without success, to burn brick on the property of the Owl Cigar Company. An Alsatian cigarmaker employed by the company called attention to the close resemblance of this clay to the German fuller's earth. As a result of this suggestion, the clay was tested and found to be fuller's earth, and the industry was developed. This discovery caused considerable excitement, and supposed deposits of fuller's earth were reported from a number of States. The material in most of these deposits, however, was found to be of no value as fuller's earth. Since the discovery, Florida had been the leading State in production. During the early history of the industry fuller's earth was produced in only two or three States. In 1897 to 1899 it was reported from Florida, Colorado and New York, with a very small production from Utah; in 1901 Arkansas was added to the list. From 1904 to 1907 Arkansas was the second largest producer. Shortly after its discovery in Florida, fuller's earth was found in Georgia, but Georgia did not appear as a producer until 1907, when it was the third largest producing State; it ranked second in 1909 and 1910. In 1904 Alabama and Massachusetts reported production, in 1907 South Carolina and Texas first appeared, and in 1909 California entered the list.

The principal use of fuller's earth in this country is in bleaching, clarifying, or filtering of fats, greases and oils. The common practice with mineral oils is to dry the earth carefully after it has been finely ground, and run it into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. As a result, the oil that first comes out is perfectly water white and much thinner than that which follows. The oil is allowed to continue percolating through the earth until the color reaches a certain maximum shade. Then the fuller's earth itself is clarified by a steaming process and used over again. With vegetable oils, however, the process is radically different. The oil is heated beyond the boiling point of water in large tanks, from 5 to 10 per cent. of its weight of fuller's earth is added, and the mixture is vigorously stirred and then filtered off through bag filters. The coloring matter remains with the earth, the filtered oil being of a very pale straw color. American fuller's earths are better adapted than the English earths for use on mineral oils, but the English earths are superior for the treatment of fats and vegetable oils. In clarifying vegetable and animal fats with American earths a more or less disagreeable taste is left—just why has never been determined.

To show the growth of the American industry it is only necessary to state that from 6900 tons in 1895 the production increased to 33,486 tons in 1909. This was the maximum, the output for 1910 being 664 tons less. Florida was the leading producing State in 1910, furnishing 57.38 per cent. of the total output, or 18,832 short tons. The other producing States, named in the order of their rank in output and value in 1910, were Georgia, Arkansas, Texas, California, Massachusetts, South Carolina and Colorado.

Those of our readers who are interested in the subject may obtain a copy of Mr. Middleton's report upon application to the director of the Geological Survey at Washington, D. C.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Ventilation of Turbine Generators

It is well known that the output of the type of alternating-current generator used with steam turbines is limited entirely by the heating of its inner parts; the machines are so small for their output (by reason of their high rate of speed) that ventilation of them is difficult. Forced ventilation by means of external fans driving air into and through ducts in the machine has been employed in many cases; in others, the fans for forcing the air through the machine have been attached to the ends of the rotating member. All of these expedients have extended the limit of safe full load, as compared with natural ventilation.

A method which comes within the last mentioned general class but which appears to be exceptionally efficient has been devised by Charles F. Baker, of Newton, Mass., and is illustrated herewith. Mr. Baker uses a series of peculiarly shaped fan blades set into openings in two disks which are mounted on the shaft, one at each end of the rotor, as represented in Fig. 1. These fan blades or vanes bear a slight resemblance to the buckets of an impulse waterwheel, as a glance at Fig. 2 will show; their curve, however, is much flatter and the concavity much shallower. Owing to their shape and the extension of the inner lips beyond the inner faces of the disks, the fan vanes combine the effects of both the turbine and the centrifugal types of blower; the portions of the vanes on the outside of the disks act to force the air in the axial direction and after it gets inside the disks, the vane lips act like the blades of a centrifugal fan and force part of the air outward radially through the overhanging stator windings. The disks are made as large as possible, just clearing the supporting rings which are set within the overhanging portions of the stator (armature) windings. Both axial and radial ducts are provided in the rotor core, so that the air which is blown into the core axially escapes radially, passing out finally through ducts in the stator core.

Mr. Baker informs us that a 2000-kilowatt generator equipped with this type of ventilating fan carried a load of 3000 kilowatts with a maximum temperature rise of 38 degrees, Centigrade, which was 6 degrees less than its normal temperature rise with the normal load of 2000 kilowatts. Fig. 3 shows the field magnet of this generator with the Baker fan vanes and disks attached; it illustrates very effectively the relatively insignificant space occupied by the ventilating device.

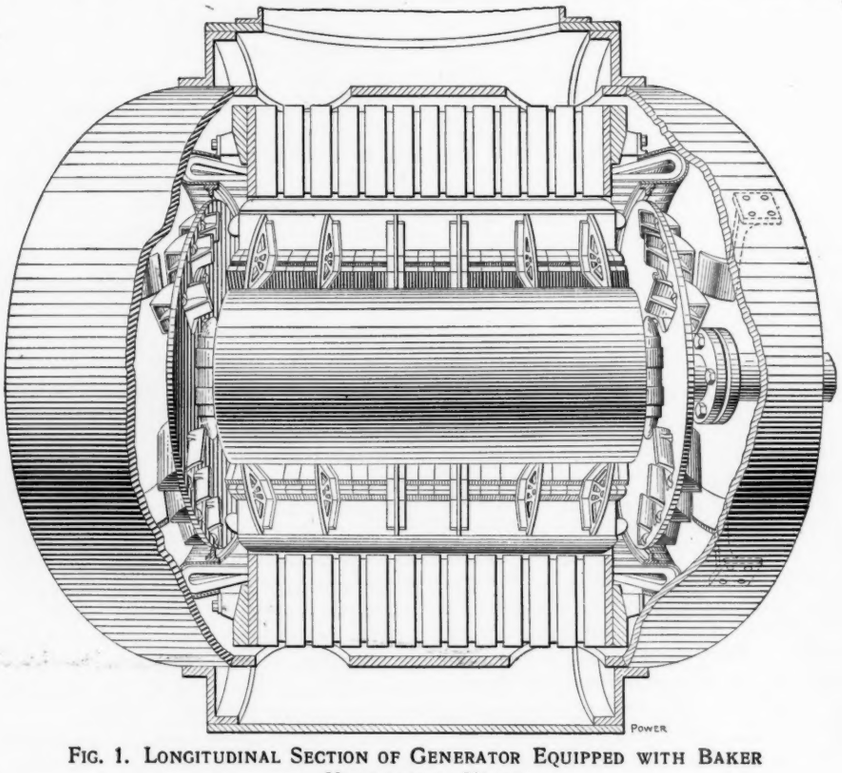


FIG. 1. LONGITUDINAL SECTION OF GENERATOR EQUIPPED WITH BAKER VENTILATING VANES

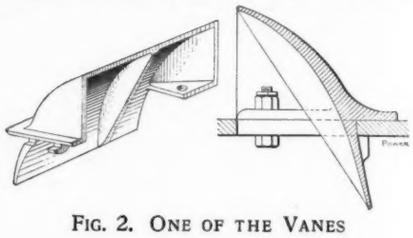


FIG. 2. ONE OF THE VANES

LETTERS

Parallel Operation of Alternators Driven by Waterwheels

In the issue of June 27, H. T. Dean asks about the parallel operation of alternators driven by waterwheels in separate stations. The question of good operation under such conditions depends very largely upon the generator and the wheel. Generators should be purchased which have inherently good character-

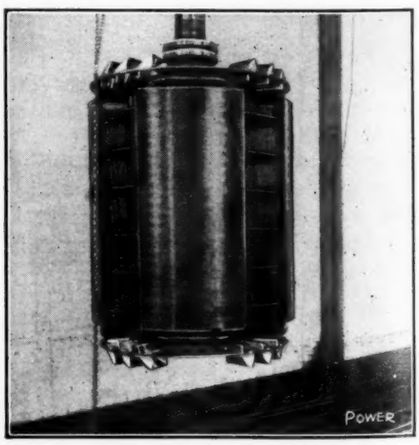


FIG. 3. ROTOR EQUIPPED WITH VANES

istics for parallel operation, and too close regulation should not be attempted. There are built generators having what is known as damping windings, which are very well adapted for work of this character, owing to the fact that these windings to a large extent prevent hunting. With generators of this kind or generators having sufficient inductance to hold each other together, there should be no difficulty in their being installed at the different locations, provided the governors are of moderate sensitiveness and not allowed to overrun, and allowing one of the generators to govern for the three, with its governor set rather more sensitively than the other two.

As it is desired that the small units should operate at full capacity constantly, it would be good policy to have the waterwheels of these generators of a capacity which would cause them to slow down when the load reached the maximum point desired, thus automatically throwing the load upon the larger generator. With both of the smaller wheels arranged in this way these wheels would carry their maximum load continuously; any excess load would be automatically thrown upon the larger machine.

The instruments required at each station in order to operate these units in parallel would be a voltmeter to indicate the voltage on the phases, ammeters to indicate the load currents and a synchronizing equipment for use in throwing them on the line. A power-factor indicator might also be installed to good advantage.

In putting the machines upon the line, in case one is operating, the second machine should be started up, brought up to speed and voltage, then the machines gradually brought into synchronism. To do this will require that the governors be provided with a loading and unloading device, by means of which the speed of the machine can be adjusted to a moderate extent. When the machines are exactly in synchronism and the voltages of the machine and of the line are the same, the switch is closed, throwing the incoming machine on the line. In order to make this machine pick up its load, the speed is increased more or less, depending upon the amount of load required for the machine to take, by means of the speed-adjusting device on the governor, as alternators do not divide their load in accordance with the voltage but in accordance with the power delivered to them by the prime mover, in this case the waterwheel.

In order to take a machine off the line, the speed of the waterwheel is decreased slightly by means of the speed-adjusting device on the governor until the machine drops its load, as shown by the ammeter. When the load has reached zero or approximately zero, the line switch is opened and the machine disconnected from the line. The wheel can then be shut down and the field circuit opened, after the resistance has all been cut in.

HENRY D. JACKSON.

Boston, Mass.

Under the conditions described by Mr. Dean, parallel operation can be satisfactorily accomplished by running the small units without governors, the only disadvantage being that if the load should all be taken off suddenly by feeder fuses blowing or some other cause, the two smaller machines would run away unless the large wheel dragged hard enough to hold them or unless there was an attendant at hand to shut the gate. Except for this objection, the scheme is entirely practicable; I have operated machines under the same conditions and had no trouble.

For instruments, in addition to the synchronizing lamps with their necessary connections, on the switchboard for the 200-kilowatt machine I would add a power-factor meter, a frequency meter and an indicating wattmeter. I should install at least one feeder panel having the necessary switches and cutouts, also an indicating wattmeter to show the total load; then, if any accident should happen to the large unit, part of the load could be carried with the other machines if it was steady enough, as a lighting load or some motor loads might be.

On the boards for the smaller machines I would provide an alternating-current voltmeter, a frequency meter and an indicating wattmeter. It might also be desirable to add field ammeters but they are not necessary on such a small installation, as readings can be taken from time to time with portable instruments. I prefer indicating wattmeters to ammeters because of the probable flow of wattless cross-currents which would make it hard to determine whether the machine was loaded up or not.

To throw one of the small machines on the line, both field resistances should be reduced so that when the speed is near normal the voltage will build up and cause the frequency meter to indicate. This speed should be attained by opening the waterwheel gate as much as is necessary; after doing this a few times, the operator will know just about how much to open it. Assuming that the frequency is 60 cycles, when the meter indicates about that and the proper voltage is attained, the synchronizing plug should be put in and if the lamp goes on and off very rapidly, then the gate may be adjusted one way or the other to find whether the machine is above or below the speed of the other generators; if above, it should be closed a very little so that the fluctuations of the lamp will be very slow; then, at the proper instant, just as the lamp shows synchronism, the main switch should be thrown in, after which the gate should be opened wide and the voltage raised to compensate for the drop due to the load, which will be steady on these machines, all fluctuations being taken care of by the large unit.

To throw one of the units off the line, the field resistance should be partly cut in and the wheel gate slowly closed until the wattmeter shows no load, when the main switch may be pulled and the wheel shut down entirely. At the same time the operators at the other stations should watch their voltmeters for a drop in voltage and cut out field resistance to compensate for it.

Should the load become too light to run the smaller machines at their full capacity and yet should it not be desirable to cut them out, the gates could be partly closed until they carry any portion desired. After a few trials it will be very easy to manipulate the three units under all conditions in reason.

G. H. KIMBALL.

East Dedham, Mass.

Referring to Mr. Dean's inquiry as to whether or not it would be desirable to place governors on two small waterwheels located at different points and driving alternators to be paralleled with a 200-kilowatt machine now in operation, I should say that it is not absolutely necessary but will be most desirable, for it must be remembered that the dividing of loads on alternators in parallel is a question of power only, and the load cannot be shifted from one machine to the other (although many engineers insist that it can) without a change in speed of the prime mover or, more strictly speaking, a tendency thereto.

Therefore, if a unit driven by a governed waterwheel be paralleled with a unit operating without a governor, there exists a condition where one unit (with the governor) has a speed regulation of, say, about 4 per cent. from full load to no load, and the other unit (without a governor) has a speed regulation of practically 100 per cent. from full load to no load; for, if the water supply is not regulated the unit will naturally speed up as the load is taken off. In a way, however, this would accomplish one point which Mr. Dean desires to cover, namely, for the two smaller units to work at maximum capacity constantly. In paralleling units with and without governors, however, an unsatisfactory condition will exist, as it must follow that alternators driven by prime movers with different regulation will cause cross-currents to flow between the machines and a poor power factor, necessitating constant hand regulation of field strength, not to mention the constant danger of the units without governors running away.

I think that the best method of operating the units in question would be to have governors on all the waterwheels; it will be advisable to provide each generator with one voltmeter, an ammeter

for each phase, an indicating kilowattmeter, a synchronizer and a power-factor indicator. The method of paralleling should be as follows:

The incoming machine should be brought up to synchronism, the voltage regulated to correspond with that of the line, and when the machines are in step the incoming unit thrown in, at which moment the ammeters and kilowattmeters will probably indicate zero. The governor of the incoming unit should then be adjusted so as to give that unit a tendency to speed up and take any desired portion of the load. In taking a generator off the line, either the governor can be adjusted so that its generator carries practically no load, when it may be taken off the line, or, if it is undesirable to touch the governor after it is once set, the water supply can be otherwise throttled and the generator taken off the line when its load has fallen to about zero; when again starting up, it can be brought up to speed under the hand gate wheel and, after paralleling, the gate opened, allowing the speed to be regulated by the governor.

P. C. OSCANYAN.

Newark, N. J.

In order to operate three waterwheel alternators in parallel under the conditions described by Mr. Dean, I think that it will be necessary to have no additional instruments for the 200-kilowatt generator except, of course, a synchronizing outfit; but a power-factor indicator and a frequency indicator would be very useful when running in parallel with the other generators. The switchboard of the smaller alternators should have the same instruments as that of the large one.

The method of cutting in one of the smaller units would be to bring the generator up to speed by hand regulation of the waterwheel gate and to synchronize as usual; then open the gates wide and let the generator carry all the load that the wheel can pull, leaving regulation to the large machine.

No governor is necessary on either of the small wheels, but if a governor is used it should be set, after the machines are paralleled, for a slightly higher speed than is desired in order that it will keep the gate wide open and act as a speed limit if the generator should lose its load.

In cutting out one of the smaller generators, simply close the wheel gates until the generator load is reduced to nothing and then cut it out.

When running these machines in parallel it will be necessary to adjust the field current so that the power factor of each generator will be the best obtainable under the conditions of load; if the larger machine has spare capacity and the smaller ones are loaded, by strengthening the field of the former and weakening those of the latter, the kilovolt-amperes of the smaller machines can be reduced.

E. T. REED.

Woonsocket, R. I.

Considering Mr. Dean's problem of operating separately located hydraulic turbine-driven generators in parallel, I should say that very much depends on the nature of the load. If the load is mostly lamps, with only a few small motors, and the load changes are gradual, the system should work well with a governor on the large machine only. On the other hand, if there are large motors on the line which are frequently thrown on and off, they will be liable to cause hunting of the small generators which might cause either one or both of them to fall out of step or to run as synchronous motors, thus adding to the load on the large generator. This could be overcome, in part, by supplying both smaller waterwheels with governors set so as to be rather sluggish in their action. It would be better in either case to have the exciter of the large generator separately driven, preferably by a small steam or gas engine.

On all three-phase systems the load should be as evenly balanced as possible between the phases and the three ammeters on the main switchboard will tell when this is true and also be of use when further balancing is necessary.

As the two small generators are to be operated at full load when on the line, all of the regulating should be done at the main power house.

The instruments needed on each of the switchboards for the small generators would be one wattmeter, one ammeter on the generator side of the main switch, one synchronism indicator or synchronizing lamps, one oil-insulated main switch, one field-circuit switch, one rheostat and one voltmeter with plugs and sockets by means of which the voltage on any phase on the line can be read when the small generator is not running. The attendant should also be able to use this voltmeter to read the voltage on the small generator when the main switch is open. I do not think it would be necessary to have an ammeter and voltmeter on the exciting circuit of either of the small generators and an indicating wattmeter would be the only new instrument required on the 200-kilowatt switchboard.

To put one of the small generators on the line, if its turbine has no governor, first determine by experiment where the handwheel on the rheostat has to be set to give a voltage about 1 per cent. above that on the line with the generator running at synchronous speed. To get this, the gate on the turbine should be only partly open. Then put in the synchronism indicator plugs and, when the two generators are in step, close the main switch. The voltage on the small generator being a little high, it will immediately take part of the load; therefore, the gate on the turbine should be opened a little more. Then by gradually cutting out the resistance in the field circuit and opening the gate of the turbine the generator can be made to take full load.

To cut out a generator, reverse the order by slowly cutting in resistance in the field circuit and at the same time closing the gate of the turbine until the wattmeter shows no load. The main switch may then be opened and the unit shut down. It may take some practice to do this without causing a fluctuation in voltage but with ordinary care one should have no trouble. The only difference there would be if the small units were supplied with governors would be that it would not be necessary to regulate the gate of the turbine.

LEONARD H. HOLTZAPPLE.

Winona, Mich.

Referring to Mr. Dean's inquiry in the June 27 issue of POWER, I see no reason why the machines could not be run as he desires. There should be a governor on each of the waterwheels; when alternators operate in parallel, each will carry an amount of the load proportionate to the power received from its prime mover and that power must be determined by a governor. A panel switchboard will be needed at each station, as well as lightning arresters. The boards should be equipped with the usual ammeters and switches for the generator and the exciter, with voltmeters for both machines, rheostats and circuit-breakers (or fuses) and switchboard transformers and synchronizing lamps.

Two methods of connecting synchronizing lamps are used, the one for "synchronizing dark" and the other for "synchronizing bright." With the first method, the synchronizing lamps are dark when the incoming machine is in phase with the busbar current; with the latter, the lamps burn at maximum brilliancy when synchronism exists. Whichever method is used, the speed of the incoming alternator should be adjusted until the fluctuations of the synchronizing lamps are very slow; this will enable the attendant to close the generator switch with more certainty at or near the moment of synchronism. After the incoming machine has been synchronized and thrown on the line, its waterwheel gate can be opened gradually until it is wide open and the governor is handling the wheel. If this is done and the field excitation is adjusted carefully by means of the rheostat, the voltage of the line will not be disturbed by cutting in the machine.

Automatically operated oil switches are commonly used, for synchronizing and cutting in, instead of the main switch in many large power stations, and they save much time both in putting machines in parallel and in shutting them down.

R. A. CULTRA.

Cambridge, Mass.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Equipment of the Gas Power Yacht "Progress"

For some time past the possibility of using internal-combustion engines for ship propulsion has been attracting the attention of marine engineers in all parts of the world. The simplest solution of the problem consists, no doubt, in adopting oil as the fuel to be used, since this gets rid at one stroke of all difficulties connected with the producer; but though this is the simplest method of adapting the internal-combustion engine to marine purposes, it cannot be considered as generally applicable, because the cost of oil fuel in many parts of the world is quite prohibitive. It seems certain, therefore, that if the ship of the future is to be fitted with internal-combustion engines, the plant must be one capable of using gas derived from ordinary coal. This being so, the marine gas-power plant herein described is of great interest.

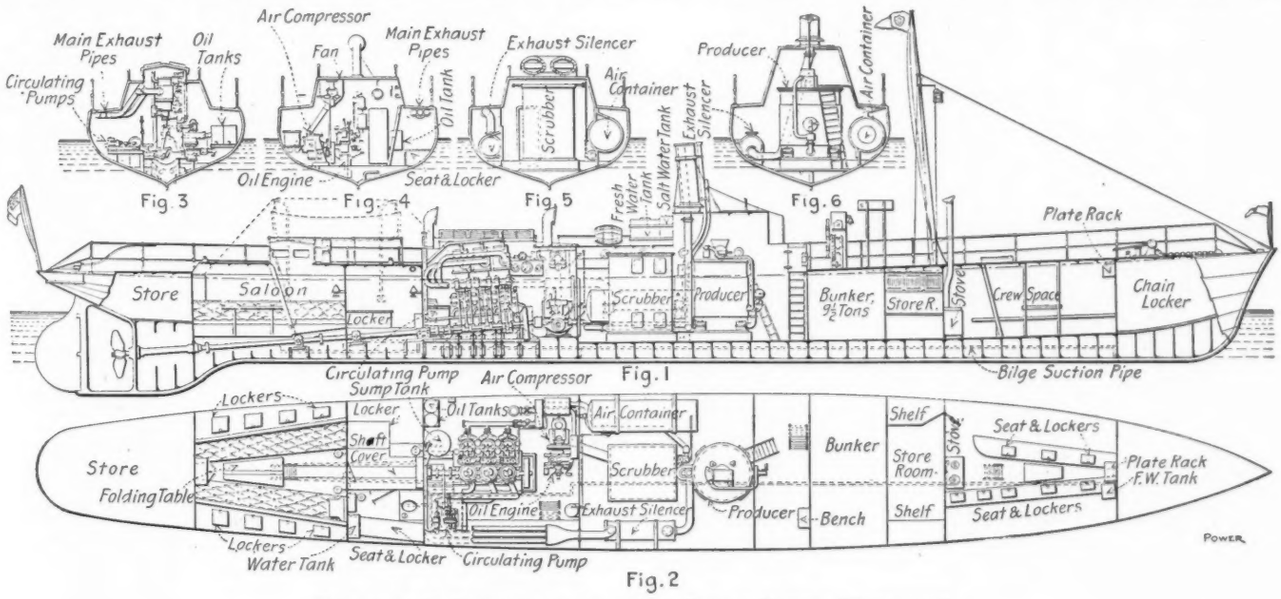
The original designs were got out about three years ago, and appeared to give such promise of success that a syndicate was formed to build an engine and install it in a small boat, with a view to having the efficiency of the system tested and its weak points eliminated by the light of actual experience. In essentials the system remains the same as originally designed, but, as is practically always the case with a departure from established practice, various difficulties connected with the subsidiary details arose and have had to be overcome by a process of trial and error.

The engine is a double-acting producer gas engine, with three cylinders 8¼ inches in diameter by 9 inches stroke, driving the propeller direct without the interposition of any form of gearing. It operates on the two-stroke cycle and develops 100 indicated horsepower when running at 200 revolutions per minute. The gas is supplied by a suction producer which has been worked with anthracite, with coke, and with coalite; the latter is said to have proved very satisfactory, there being less clinker formed than with coke.

The engine, with its producer and auxiliaries, was fitted on board an old torpedo boat originally driven by steam engines. The original propeller and propeller shaft was retained, but it was necessary to rebore the stern post, as the center of the gas-engine crank shaft was at a higher level than that of the original engines. The space available around the engine was naturally somewhat cramped in view of the fact that the installation to be tested was an experimental one, with which it may always safely be assumed that certain modifications in details will be proved by experience to be necessary or advisable. On the other hand, the producer, though large enough for an engine of more than double the output, required much less space than was occupied by the original boiler.

The arrangement of the plant as finally fitted on board is well shown in Figs. 1 to 6. The producer and the scrubber stand in the stokehold, the air reservoir used in reversing the engines being fitted in on the port side of the scrubber, while the exhaust-silencer is on the starboard side, as shown in Figs. 2, 5 and 6. This exhaust-silencer, it should be added, has proved very efficient, the noise, with the engines running, being hardly greater than with steam.

The main engine is illustrated in Figs. 7 to 10. As shown in Fig. 9, provision was made for water cooling the piston, but this has proved unnecessary. Each cylinder, as may be seen, is constructed somewhat on the well known Körting lines, the exhaust taking place through ports provided around the middle of the cylinder, these ports being uncovered by the piston as it approaches the end of each stroke. A large three-cylinder air pump, the piston displacement of which is from two or three times as great as the displacement of the pis-



FIGS. 1 TO 6. SECTIONS OF THE GAS POWER YACHT "PROGRESS"

tons in the working cylinders, is arranged as indicated in Fig. 9, occupying much the same place as the air and circulating pumps in a common type of marine engine. The linkage (best seen in Fig. 10) by which the pump is driven is arranged so that the pump piston is in quadrature with the main piston; that is, the air-pump piston is at midstroke when the main piston is at the end of its stroke. Each cylinder of the air pump has also ports provided at the midpoint of its stroke, and it is through these ports that the gas supply (mixed with air) is sucked in from the producer. As a consequence, during the first portion of the air-pump stroke, when the piston is between these ports and the air ports at the end of the cylinder, pure air alone can be sucked in. The supply pipes for this air are at *A* and *B* in Fig. 9. Upon the descent of the air-pump piston, pure air enters at *A*, partially filling the long connecting pipe *C*. Later on, the air-pump piston uncovers the ports in its cylinder, and during the remainder of its stroke mixture is drawn in. Just after this piston reaches the end of its stroke, the working piston uncovers the exhaust ports in the main cylinder, so that the pressure there has been reduced to that of the atmosphere. Hence, on the air-pump piston beginning its return stroke, the valve *D* is lifted and the pure air which has collected at the top of the pipe *C* enters the cylinder and washes out the spent gases through the still open exhaust ports. The continued upward motion of the air-pump piston forces into the working cylinder a further supply from the pipe *C*, but this supply now contains gas, and the charge

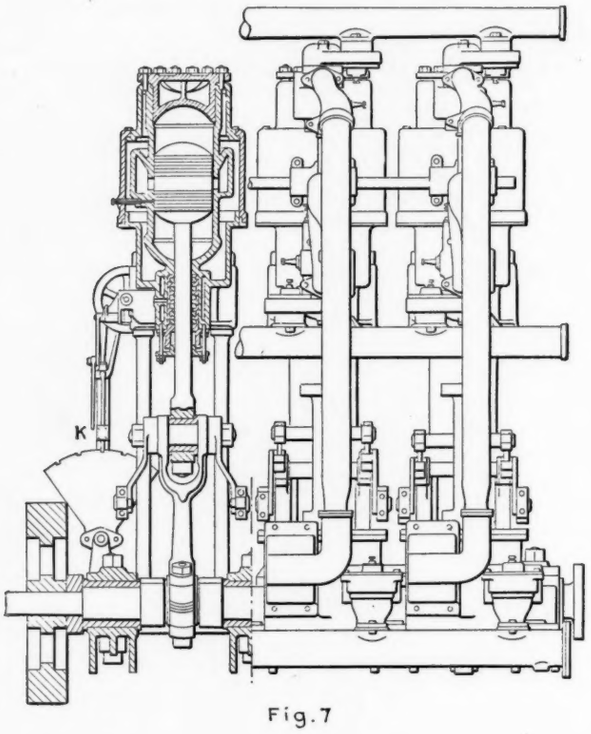


Fig. 7

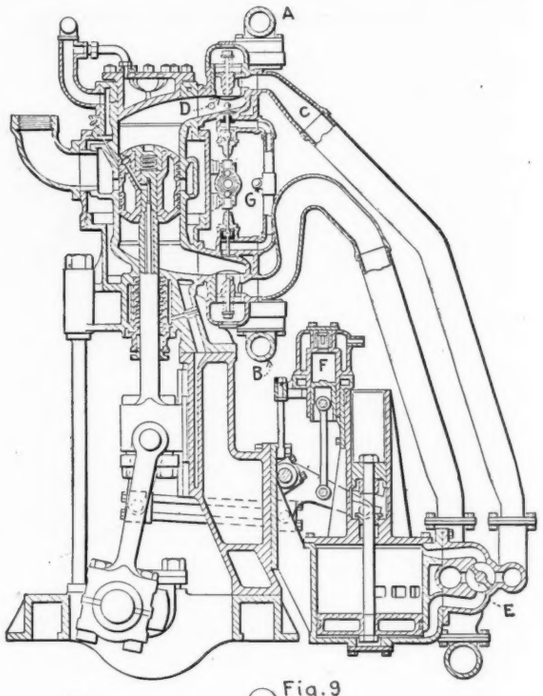


Fig. 9

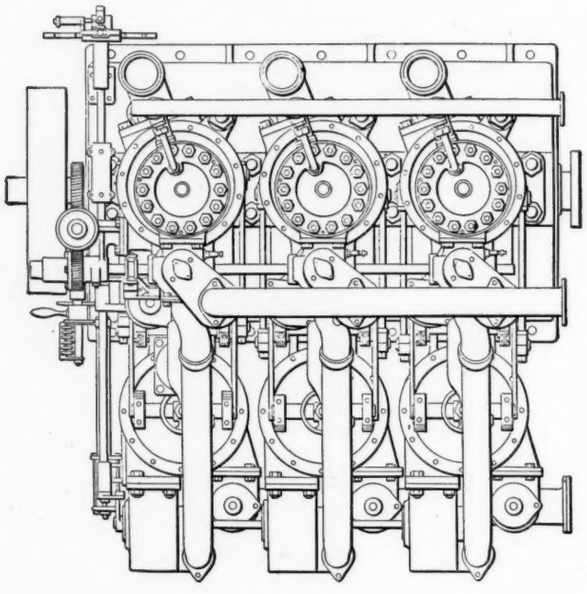


Fig. 8

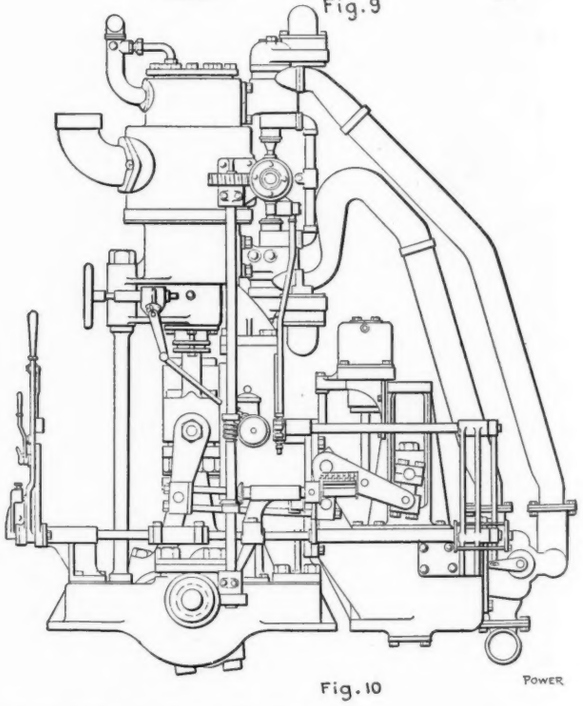


Fig. 10

FIGS. 7 TO 10. THE 100 HORSEPOWER ENGINE OF THE YACHT "PROGRESS"

of mixture in the cylinder is compressed and fired in the usual way.

The Lodge electric ignition system is used and it has been found by actual experiment that with this a good spark will pass even when the plug is covered with a deposit of heavy oil. Ignition current is supplied by an accumulator

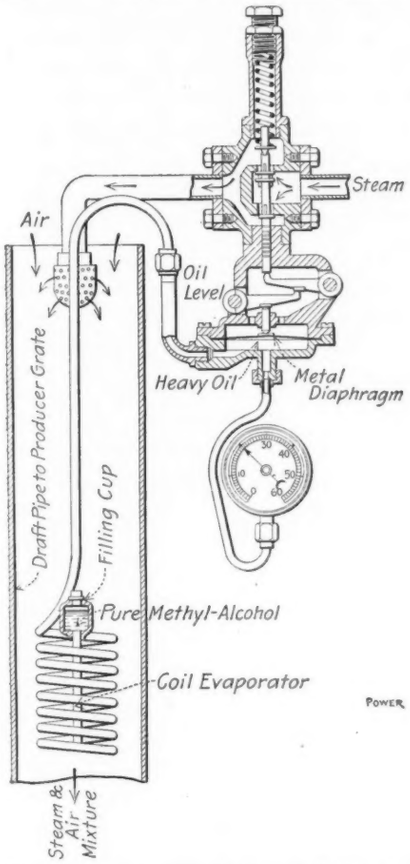


FIG. 11. REGULATOR OF STEAM SUPPLY TO PRODUCER

which is kept charged by a small dynamo driven from the main engine.

The lower end of the working cylinder is connected to the other end of the air-pump cylinder and is scavenged and charged in exactly the same way as is the upper end. When the engine is to be reversed, the connections between the ends of the working cylinder and the ends of the air pump are changed over by the four-way valve shown at *E*, Fig. 9. By rotating this valve through a right angle the top of the working cylinder becomes connected to the bottom of the air pump, and *vice versa*.

An additional air pump, shown at *F*, Fig. 9, furnishes the supply of compressed air for starting and reversing the engine. The air supply for this purpose is led to the engine by a pipe which passes along the back of the cylinders as indicated at *G*, Fig. 9. Branches connect this pipe with a couple of balanced valves normally held closed by springs and opened by cams on a cam shaft driven by spiral gearing from the main shaft, as shown in Fig. 10. These cams do not "positively" open the valves, but do so through the intermediary of buffer springs. Hence, once the engine starts firing and the pressure consequently rises in the cylinder, the cams are no longer able to open the valves, but merely compress the springs, so that the air supply is automatically shut off as soon as it is no longer required. In starting or reversing the engine the supply of compressed air is required for one or two revolutions at most. This feature affords great economy in the consumption of compressed air, and the engines have frequently been manœuvered to a far greater extent than would ever be required in practice, with but the small auxiliary compressor running and without material loss of pressure in the reservoir. In rough weather, if the supply of air is left on, it will prevent the accidental stoppage of the engine when it has been throttled down to prevent racing and the propeller is suddenly reimmersed. The range of speed over which the engine will run satisfactorily is from 40 up to 210 revolutions per minute.

The reverse lever of the engine is shown in its neutral position at *K*, in Fig. 7. It will be seen that there are two notches on each side of the central notch. Of each of these pairs of notches, that nearest the neutral notch corresponds to the running position of the engine, and the outermost to the starting position. With the lever in the starting position the cam shaft controlling the air supply is shifted so as to operate the air valves in correct sequence for the desired direction of rotation, and at the same time the spark is retarded in each cylinder and the four-way gas valves *E* are simultaneously moved so as to connect the appropriate end of the air cylinder to the top of the main cylinder. As soon as the engine starts firing, the lever is moved back to its running position, an operation which moves the cam shaft clear of its followers. As instancing the handiness of the engine, it may be stated that, in coming out of dock on one occasion twenty-six different movements were made in the course of 21 minutes. The time taken to reverse has been found to be from three to four seconds after the order is given.

The main difficulty experienced in securing easy manipulation of the engines was due to the producer. In land practice a suction-gas plant, once started, runs commonly without violent fluctuations in the output demanded. With a marine engine, when coming in or out of port, the conditions are very different, and it was found that special steps must be taken to maintain the quality of the gas and the strength of the mixture, whatever the temporary draft on the producer. For producers furnishing gas to a land engine the supply of water or of steam can be conveniently adjusted by hand, but experience showed that an automatic control was desirable for the supply to a marine producer.

To provide this control, the apparatus illustrated in Fig. 11 was devised. The steam supply (at atmospheric pressure) is obtained from a small separately fired boiler. The steam is delivered through a rose sprayer fixed, as shown, at the top of the air pipe leading beneath the grate of the producer. Lower down in this pipe a coil of tubing is fixed, which is charged with pure methyl alcohol. The top of this coil is connected to a pipe leading to a chamber below a flexible diaphragm, which chamber is filled with heavy oil. A series of magnifying levers transfer any motion of the flexible diaphragm to a balanced valve which controls the supply of steam to the sprayer. At full speed this valve is fully open and a full supply of air and steam is drawn through the draft pipe into the producer. When the speed of the engine is suddenly reduced, the vacuum in the producer falls off and there is less suction in the draft pipe. Therefore less air is drawn in, and the coil containing the methyl alcohol is raised in temperature by the excessive supply of steam. As a result the vapor pressure inside this coil is raised and the increased pressure, acting on the flexible diaphragm, moves the latter, closing the steam valve more or less. When the speed of the engine is increased, after having been reduced, a larger quan-

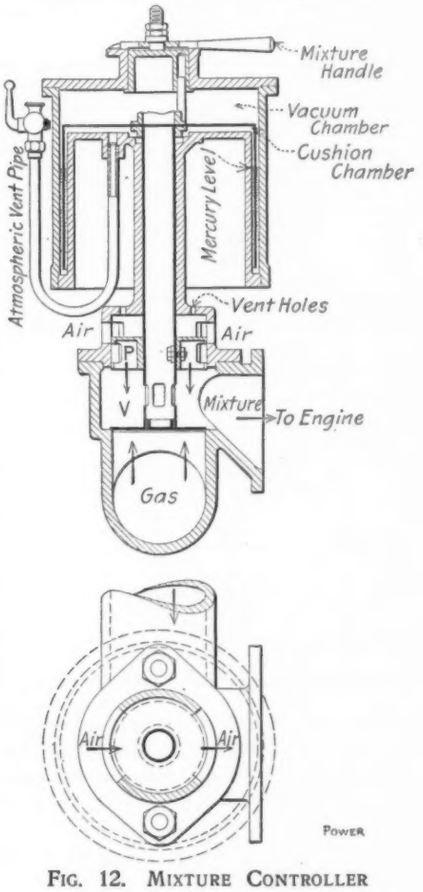


FIG. 12. MIXTURE CONTROLLER

tity of air is sucked into the draft pipe; this cools down the coil, lowering the pressure within it, and the steam valve is then forced open by the spring above it.

To maintain automatically the proper relative proportions of gas and air in the charge supplied to the engine, the device illustrated in Fig. 12 is employed. This is essentially the same in function as some of the automatically adjustable carbureters used on motor-car engines.

A bell dipping into mercury is provided inside a "vacuum" chamber as indicated. This bell is connected by a hollow stem to a gas valve shown below at *V*, and has also mounted on it at *P* a looscly fitting piston, which, when in its lowest position, shuts off all connection between the outer air and the supply pipe to the engine. When a charge is being drawn into the latter, the partial vacuum produced extends to the space above the bell through the hollow stem. The bell therefore rises, opening simultaneously the gas valve *V* and the air ports. The air which enters passes through slots in the air piston, and by rotating the latter, the relative proportions of air and gas can be adjusted. This adjustment is made by turning the mixture handle, shown at the top in Fig. 12. The position of this having been once adjusted to suit the quality of gas being used, the "carbureter" automatically maintains the proper proportion of gas and air during all changes of speed of the engine.

Both the barrel and the heads of the cylinders are water cooled, the water being circulated by a small pump driven by chain gear from the crank shaft. A second pump supplies the water needed for the scrubber.

For starting up the producer and for charging the reservoir of compressed air while in port, a small oil engine is provided. This drives a fan which gives the draft necessary for starting up the producer and a small Reavell air compressor for charging the reservoir.

The vessel is owned by the Empire Oil-Engine Syndicate, Limited. C. H. T. Alston was responsible for the design of the engine, which was built for the syndicate by F. W. Rowlands & Co., of Birkenhead, and the consulting engineer, who has been associated with its development from the beginning, is P. T. Houston, of Houston & Gall. It is intended to build a second engine to develop from 350 to 400 horsepower, and a corresponding gas plant, in both of which a number of improvements in detail will be embodied. This plant will be installed in a vessel of the commercial type.—*Engineering.*

TABLE OF RESULTS OBTAINED IN TESTS MADE BY E. A. ALLCUT

Trial	A	B	C	D	E	F	G
Duration, hours	4	4	4	3.67	4.25	4	4.083
Coal supply, pounds	59.8	62	60.25	57	63	62	63
Coal supply, pounds per hour	14.95	15.5	15.06	15.55	14.83	15.5	15.4
Heat value of coal, B.t.u. per pound	14,250	14,300	14,250	14,950	14,500	14,200	14,600
Heat per hour in coal supplied, B.t.u.	213,000	222,000	214,500	232,000	215,000	220,000	225,000
Moisture, per cent. by weight	3.97	3.58	4.29	2.55	3.4	3.52	3.04
Ash, per cent. by weight	3.41	3.26	3.57	2.2	3.06	3.33	2.87
Air supply at 32° F. and 14.7 pounds per square inch, cubic feet per hour	794	778	750	863	798	774	733
Temperature of air	56.4	60	49	50	45	50	49
Air, pounds per hour	64.1	62.8	60.5	69.6	64.4	62.4	59.2
Nitrogen, pounds per hour	49.3	48.3	46.6	53.6	49.6	48.0	45.6
Oxygen, pounds per hour	14.8	14.5	13.9	16.0	14.8	14.4	13.6
Air per pound coal, pounds	4.29	4.05	4.02	4.47	4.34	4.03	3.84
Water in air, pounds per hour	0.24	0.413	0.385	0.316	0.251	0.263	0.298
Water feed, pounds per hour	0.0	3.175	5.95	10.95	10.4	14.375	17.25
Temperature of water	—	52	46	34	32	49	35
Total water to fuel bed, pounds per hour	0.24	3.588	6.335	11.266	10.65	14.64	17.55
Water per pound coal	0.016	0.232	0.421	0.724	0.718	0.945	1.14
$\frac{\text{Weight water per hour}}{\text{Weight air per hour}}$	0.0037	0.0572	0.1047	0.1617	0.1655	0.235	0.297
$\frac{\text{Weight oxygen from water}}{\text{Weight oxygen from air}}$	0.0144	0.220	0.405	0.625	0.642	0.904	1.145
Gas at 32° F. and 14.7 pounds per square inch, cubic feet per hour	970	1040	1050	1238	1165	1095	998
Cubic feet gas per pound coal	65	67.2	69.8	79.6	78.6	70.7	64.7
Composition by volume:							
N_2 per cent	63.3	59.4	56.7	55.2	54.2	55.6	58.7
CO per cent	28.5	26.5	24.5	23.0	23.5	20.7	20.0
CO_2 per cent	7.2	7.5	7.7	8.0	8.5	9.7	8.8
H_2 per cent	0.5	6.1	10.5	13.3	13.5	13.3	11.5
CH_4 per cent	0.5	0.5	0.6	0.5	0.3	0.7	1.0
Total combustibles	29.5	33.1	35.6	36.8	37.3	34.7	32.5
Nitrogen, pounds per hour	48.9	48.5	46.6	53.5	49.5	47.8	46.0
Hydrogen, pounds per hour	0.027	0.355	0.617	0.925	0.88	0.817	0.645
Water decomposed, pounds per hour	0.24	3.20	5.55	8.33	7.92	7.35	5.8
Water decomposed, per cent	100	89.3	87.8	74	74.4	50.2	33
Water decomposed per lb. coal, pounds	0.016	0.208	0.369	0.536	0.535	0.474	0.376
Heat value of gas B.t.u. per cubic feet	104.3	116.8	125.9	129.5	129.6	123.9	118.3
Total heat in gas per hour B.t.u.	101,300	122,000	132,100	160,500	151,000	135,800	118,000
$100 \times \frac{\text{Heat in gas}}{\text{Heat in coal}} = e_1$	47.6%	55.0%	61.7%	69.2%	70.2%	61.8%	52.5%
Heat to vaporize water-feed per hour, B.t.u.	—	4,040	7,160	12,870	12,200	16,530	20,050
Heat to vaporize water-feed per hour, per cent	—	1.82	3.34	5.55	5.68	7.52	8.92
Thermal efficiency $e_2 = 100 \times \frac{\text{Heat in gas} + \text{heat to vaporize water-feed}}{\text{Heat in coal}}$	47.6%	56.82%	65.04%	74.75%	75.88%	69.32%	61.42%
Temperature of gas leaving generator	750	665	600	550	545	550	554
Temperature of gas leaving washer	121	120	129	116	120	120	120
Heat lost in washer per hour, B.t.u.	20,950	20,030	18,270	19,530	19,020	18,170	16,720
Heat in coal per hour, per cent	9.84	9.03	8.52	8.43	8.85	8.27	7.45
Heat lost in washer including sensible and latent heat of water vapor	—	—	19,396	20,140	19,570	19,880	24,810
$\frac{\text{Heat lost in washer}}{\text{Heat in coal}}$ per cent	—	—	9.03	8.67	9.1	9.02	11.0

Effect of Varying the Steam Supply to a Gas Producer

The accompanying table gives the principal results obtained in a series of tests made for the purpose of determining the effects of different rates of steam supply in a producer making power gas from anthracite coal. These tests were described in this department last week, but the table was accidentally omitted.

Mr. Maccoun's Piston Rings

In the drawing of a cast-steel piston which was reproduced in the July 4 number (Fig. 4, page 17) in connection with Mr. A. E. Maccoun's remarks at the Pittsburg meeting of the American Society of Mechanical Engineers, the dimensions of the piston rings were given as 1x⅜ inches. This was a draftsman's error; the correct dimensions are 1x1⅜ inches.

CORRESPONDENCE

Starting a Gas Engine with Steam

Some time ago I had charge of a city water and light plant in which two auxiliary generators were driven by a gas engine. One night before starting the gas engine to keep the steam-engine units over the peak of the load, I found the air compressor out of commission and could get no air; neither could I repair the compressor in time to start up. The gas engine was a three-cylinder vertical, with 13x14-inch cylinders, and was usually started by introducing air into one cylinder. I decided to tap the steam line and start with steam in the same way that I would with air and change the igniter in the starting cylinder on the run, as I felt sure it would be "drowned out" by the steam. Much to my surprise, however, it fired perfectly. Of course, I used no more steam than was necessary and blew out the steam line until it was quite dry before turning steam into the cylinder. This method of starting proved so satisfactory that it is still in use, after three years' trial.

Iola, Kan. C. J. BEACH.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Engineers' Hours

I have been very much interested in the articles appearing in POWER, but I have never seen anything about engineers' hours.

A few years ago I was employed as assistant engineer in a steam plant containing two boilers with a combined heating surface of about 2000 square feet, three steam turbines of 150 horsepower each, one surface condenser and the necessary auxiliaries. I got very tired of standing 12-hour shifts seven days per week, and consequently about the middle of March I told the chief that I would resign on the first of April, giving as my reasons the 12-hour shift and seven days per week.

This plant was operated 24 hours per day and two firemen, two assistant engineers and one chief engineer were employed. The chief said he was perfectly willing to put in four hours per day without an assistant, but that he had the firemen to consider also. If he put the engineers on 10 hours per day the firemen should have the same hours and the company would not sanction an increase in the force.

The following Sunday the assistant general manager came into the engine room, and asked me why I wanted to leave. I told him, and at the same time he allowed me to make a proposition. I explained that as long as the chief was willing to put in four hours per day without an assistant it would mean a very small increase in wages to put a man in the boiler room for that length of time; I told him that a satisfied employee was a good asset.

In a week the change was made, the day crew coming on at 12:30 p.m. and the night crew at 10:30 p.m. This left the chief and his man from 8:30 a.m. to 12:30 p.m., the other man being employed in another part of the plant the remainder of the day.

When the firemen were working 12 hours per day each man cleaned fires once each shift. When the third man was put on, the fires were cleaned three times in the 24 hours, and when the coal consumption was figured up for April it was found to be ½ pound less per kilowatt-hour than for March. With an output of 4000 kilowatts per day, coal costing $2.90 per ton and the wages increased 80 cents per day, the company was the gainer. Of course, it may be said that while the men were working 12-hour shifts they could have cleaned fires oftener, but I have learned that the better you treat a fireman the more money you will be ahead in the coal pile.

A. C. KIERMEIER.

Philadelphia, Penn.

Homemade Link Motion

As I desired to make a reversing engine out of an ordinary twin slide-valve engine, I removed the valves and got an exact wooden templet of the valve seats. Then a model was constructed to get the valve movement, for the valve travel of my gear was shorter than the direct-motion gear. Therefore both the outside and inside lap had to be cut down.

A bearing was secured on the engine frames, as at *A* in the illustration. Then a piece of 1x2-inch iron was forged to the shape shown at *B*. This was formed to the same arc as the sides of the link shown at *C*, which were made of 1-inch round iron. The stud in the side of the piece *B* was threaded and screwed in as far as it would go and then riveted.

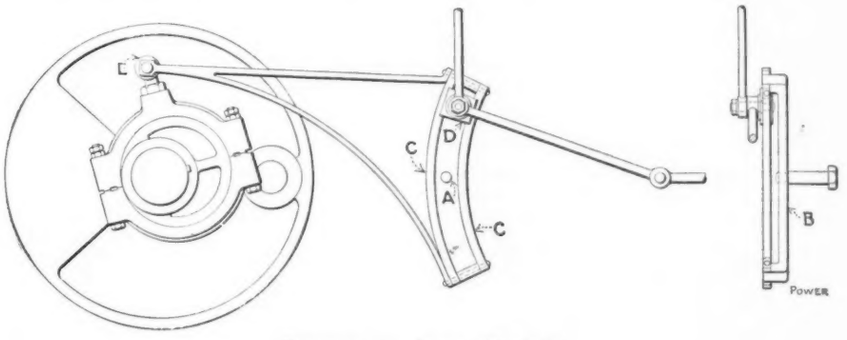
The connecting piece from the back of the link to the stud on the eccentric strap was made of ⅝-inch round stock, with a square end welded on at the eccentric end at *E*. The eccentric rods were removed and short studs screwed into their places in the straps.

The studs had threads long enough to be adjustable and leave room for a jam nut. The connecting piece from the eccentric stud to the link was held to the link by bolts passing through the pieces *B* and *C*.

The link block, shown at *D*, was made from a square hollow piece of steel. The guide bearings were made by boring through a piece of steel with a 1-inch drill, and then sawing through the center of the holes with a hacksaw. The carrying pin was threaded and screwed in and then securely riveted in place. The hollow portion of the block was babbitted in position, and made to work easily.

Short-radius rods were provided for connection from the link blocks to the valve-rod guide pins. A hanger rod connected to an ordinary rock shaft and a pair of bell cranks completed the reversing gear.

With the tools at hand it was not possible to make any of the joints adjustable, but after an entire season of hard work the link is still standing up to business.



DETAILS OF LINK MOTION

The link is rocked on a shaft or trunnion, as shown at *A*, and the block is shifted instead of the link. When the block is hooked up, the cutoff is shortened, and when the link block is in the center of the link there is no valve motion.

Reversing is easy, even when full steam pressure is on the valve, because there is no roll of two eccentrics to overcome in shifting and the valve motion is short and quick.

There is no valve lap to speak of and no lead, as the valve just covers the ports when the engine is on the center. With all this, the steam distribution seems to be good as the engines run smoothly and easily, and at any speed required by the demands of the plant.

JAMES W. LITTLE.

Fruitland, Wash.

Crowded Engine Room

Some time ago I visited a plant in an Eastern city in which three high-speed engines were installed in a room about large enough for one. In order to oil up or feel the bearings, the engineer had to climb over the outer engines to reach the middle one.

The piston rods cannot be removed in any case as a heavy brick wall stands 13½ inches from the cylinder heads. The engines have been in operation regularly for four years.

There were three pumps, one for salt water, one for water supply to boost the pressure to the building and one to circulate the water over the spray system of purifying the air coming from the outside of the building. These three pumps were placed one over the other on a separate shelf.

D. L. FAGNAN.

New York City.

Heat Units Required to Evaporate Moisture in Coal

For several days prior to a recent boiler test, there had been a steady rain, which continued throughout a good part of the day of the test. This resulted in very wet coal as shown by the chemist's analysis, which indicated 6.04 per cent. moisture. Naturally this percentage of moisture was deducted from the number of pounds of coal as fired and, therefore, did not appear in "the equivalent evaporation from and at 212 degrees per pound of dry coal."

Apparently no provision has been made in the Standard Code adopted by the American Society of Mechanical Engineers for the heat units required to evaporate this moisture, although in a very interesting and valuable article contributed by Mr. Kent, which comprises Appendix XXI to the code, under the heading "Distribution of the Heating Value of the Fuel" and referring to the distribution of the total heat value of the coal, under paragraph three, will be found the following:

"Heating to 212 degrees the moisture in the coal, evaporating it at that temperature, and evaporating the steam made from it to the temperature of the flue gases — weight of the moisture in pounds $\times$ (212 degrees $-$ t) $+$ 966 $+$ 0.48 (T $-$ 212), in which T is the temperature (Fahrenheit) of the flue gases and t the temperature of the external air."

Using this formula, 190 pounds of coal would be required for that purpose, in the specific test referred to above, but no actual allowance was made.

Naturally this quantity of coal was not available for evaporation of water in the boiler and hence the performance was handicapped to that extent. Proper provision should be made for this in the coal and the heat units required to overcome the moisture in the coal should be deducted at the same time as the moisture itself.

Suppose that this particular test was conducted to determine the acceptance of a new boiler, installed under a guarantee to attain a given evaporation, and while this 190 pounds of coal was relatively insignificant, as compared with the total number of pounds of coal used, it would make some difference in evaporation. Even though it appeared only in the hundredths column, it might have been sufficient to barely prevent the attainment of the guaranteed evaporation, whereas had the 190 pounds been deducted, the builder's guaranteed performance would have been obtained.

It so happened that no such weighty matter hinged upon the test in question, but as it might have been the case I would ask the opinion of others as to whether suitable provision should not be made.

A. M. BLUMENSTEIN.

Philadelphia, Penn.

Disk Friction Clutch

In our plant one long line shaft carries five pulleys which are mounted about 40 feet apart. Each pulley drives one large machine. The only way the machines are started or stopped is by the use of a pin clutch, as shown in Fig. 1. As the pins engaged in the hub of the driving pulleys they gave a great deal of trouble by heating, and one had to throw off the belt or put in the clutch in order to start or stop the machine. To overcome this trouble a friction-clutch pulley was designed and put on the line shaft in place of the fast pulleys. This clutch permitted the starting and stopping of the machine by the shifting of a lever.

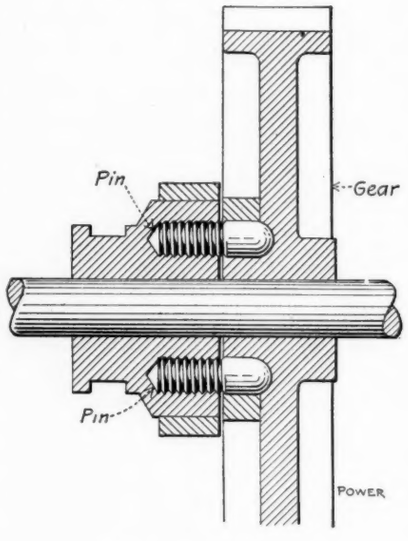


FIG. 1. PIN CLUTCH

The clutch pulley as designed and constructed embraces a new idea in its toggle movement. Fig. 2 shows the principle of the double-disk clutch. The disk A is cast in one piece with the sleeve B, and the disk C can slide on three feather keys on this sleeve but cannot turn on it. The sleeve B is keyed fast on the shaft.

The bronze ring D carries a wooden friction block E and slides with its periphery on three feather keys attached to the inside of the pulley rim F.

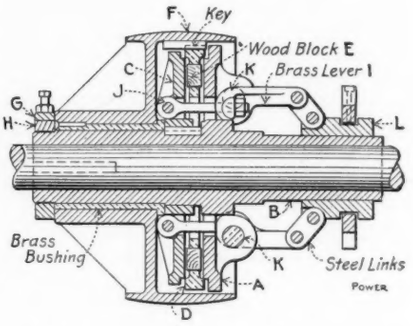


FIG. 2. SECTION OF DISK FRICTION CLUTCH

The pulley F has a brass-bushed hub and turns on the sleeve B, and is prevented from sliding laterally by butting against an offset on the sleeve B on one side and is held on the other by a cast-iron collar G threaded to the sleeve. This collar carries a steel insertion H that can be pressed tightly against the sleeve threads by a setscrew and so prevents turning.

The links I shorten or lengthen the bolts J by turning on the eccentric pin K. This is effected by moving the collar L in or out on the sleeve in the manner in which all clutches are operated.

By moving the collar L toward the clutch the link I on the pin K will turn counterclockwise. Thus the nut on the bolt J will move outward as well as the bolt itself. As this bolt is swiveled to the plate C, it will effectually draw the plates C and A against the wood blocks E. Disks A and C are continually turning on the shaft and when thrown into lock they will grip the bronze plate D and carry it around with them. But as the plate D cannot turn freely on the inside of the pulley—the three feather keys preventing this operation—it carries this pulley along with it.

A very small pressure throws the clutch into gear and the power transmitted is larger than one expects. Five of these clutches are now working satisfactorily. The pin clutch was not removed but was used as a safety device as the breaking of a pin indicates that something is stuck in the machine.

J. L. STEWART AND H. L. KOHLBERG.

Asarco, Durango, Mexico.

Experimenting with CO_2 Gases

Many engineers operating small steam plants take slight interest in some of the most uptodate methods for promoting economy. Especially is this so in the case of flue-gas analysis. Some engineers believe there is little use trying to get the manager of a small plant to buy a CO_2 apparatus and others say that they hire the best firemen they can find and expect them to get results, without attention from the engineer, or get out. This last method is wrong, for it is in the boiler room that the greatest preventable losses occur and where the engineer has the opportunity to make the greatest saving.

I became interested in flue-gas analysis about a year ago and purchased a hand analyzer. I could not afford to buy a recording instrument and I knew that the manager would not buy it. I have never regretted the expense; in fact, I regard it as the best investment I could have made, for by the use of this instrument and by experiments I have learned more concerning economical combustion than I could in any other way. The plant burns oil under return-tubular boilers so the hand instrument probably "fills the bill" better than would be the case if coal were used, especially as the load is comparatively steady.

My first analysis showed about 8 per cent. CO_2, and I started on a hunt for air leaks. I did not find many and only succeeded in raising the CO_2 to 8.5 per cent.

My next step was to give the brick settings two coats of white lead and oil paint which helped some, and the CO_2 increased to about 11 per cent. Then as the furnaces were in bad shape, the boilers were reset, but no air spaces were left in the walls, as was formerly the case.

The result convinced me that an air space in a furnace wall is a source of loss as air will leak into the furnace. With the new setting it is possible to get from 13 to 14 per cent. CO_2. The furnaces are coated every other month with whitewash in which fish glue has been dissolved. Just as little air is admitted to the furnace as is possible and at the same time secure smokeless combustion.

The gain in economy is quite noticeable as the factory is now turning out about 17 per cent. more of the finished product per barrel of oil than was the case when the analysis showed 8 per cent. CO_2, all other conditions being equal.

Some of my acquaintances express themselves as being dissatisfied with the results of their "analyzing," and this I think is caused by their expecting too much of their instrument. The CO_2 analyzer will not of itself stop any air leaks or save any fuel, but will help the engineer to do so by showing him just how little air he can supply to the fires and not produce CO.

T. P. WILLIAMS.

Brownsville, Tex.

Faultily Designed Tank Valve and Float

About four years ago I installed a pump and receiver outfit in which a float and balance valve controlled the admission of steam to the pump, as shown in Fig. 1. The pump was defective because of the manner in which the throttle valve and the float were connected.

This throttle valve *A*, Fig. 1, was mounted on top of an overhanging chamber *B*, with its stuffing-box end projecting down into the chamber that was bolted to the end of the receiver. The end of the valve stem *C* was connected to the end of the float lever by a pin *D*. The float lever *E* fulcrumed between two flat links *F*, which were suspended in the chamber *B* by a lug, as shown.

Although this arrangement looked all right the stuffing box would leak and cause the receiver to become steam bound. In order to pack the stuffing box it was necessary to remove both heads from the chamber *B*, but there was so little room in it that it was difficult to pack the valve stem.

I proceeded to alter the pump in the following manner: The balanced valve *A* was disconnected from the top of the chamber *B* and from the steam line to the pump. The receiver head was then unbolted at *H* and the float withdrawn from the receiver. The lever connecting with the float *G* proved to be a piece of gas pipe and was substituted by a brass lever having a connection on one end, as shown at *C* in Fig. 2.

An old globe-valve bonnet was screwed to one of the heads of the chamber *B*, as shown at *J*, Fig. 3, and the other head was drilled and threaded to receive the brass plug *K*. This plug had a ½-inch hole drilled into the inner end to serve as a bearing for the end of the stem *L*. A small crank *M* was then made to fit on the other end of the stem *L* and a small hole was drilled in the other end of the crank to connect with the forked end *N* of the valve stem by means of a small bolt.

The hole in the top of the chamber *B* that had been occupied by the valve was closed by bolting on the plate *P*, the joint being made tight by first inserting a rubber gasket.

After assembling the parts, and placing the balanced valve in position, a lubricator was connected to lubricate the stem of the balanced valve as well as the cylinder of the pump. The valve and float were then adjusted and no further trouble was experienced.

GEORGE LITTLE.

Passaic, N. J.

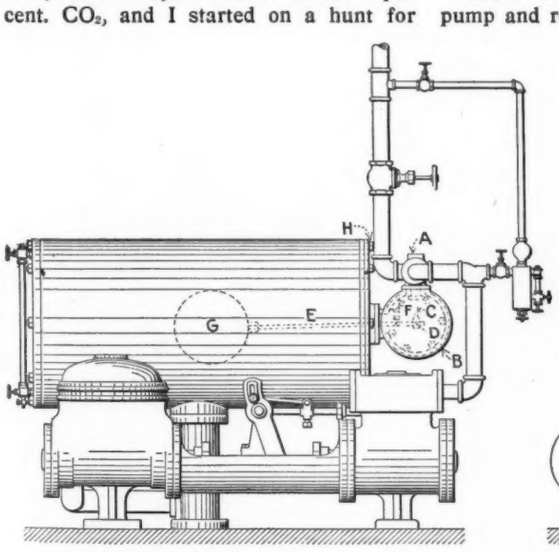


FIG. 1. SIDE ELEVATION OF THE RETURN TANK AND PUMP

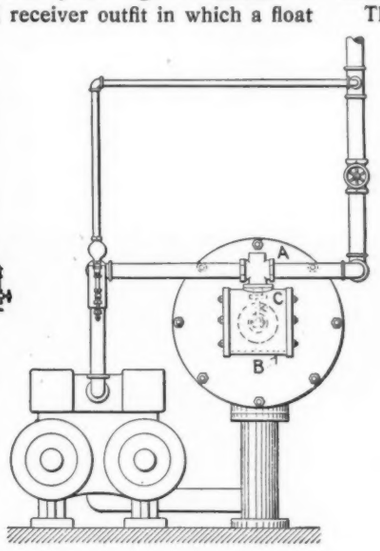


FIG. 2. END ELEVATION OF TANK AND PUMP

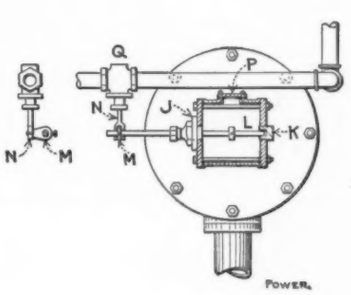


FIG. 3. DETAILS OF VALVE ARRANGEMENT

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Draining Compressed Air

In the issue of POWER for June 20, on the "Inquiries of General Interest" page, a correspondent tells of the trouble he has with water and some oil in his compressed air, and suggests that "if the air were cooled to a point lower than it would again become, and drained at the point of lowest temperature, it would not again form water." The latter phrase cannot, of course, be taken literally, as the air cannot make more water than it carries with it into the compressor, and whatever water it drops after leaving the compressor it cannot again pick up, or "form water," after it has passed along and left it behind.

The editor's suggestion of the aftercooler is undoubtedly correct, but the further statement that the air should then pass to a large air receiver "where the remaining water and oil will fall to the bottom and may be drawn off" represents theory rather than practice, and the theory is defective because it ignores some of the conditions.

The inconvenience, actual delay and expense caused by water in the pipes

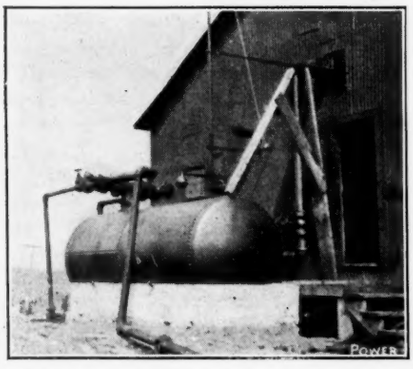


FIG. 1. AIR RECEIVER

are sufficiently familiar to all who have to do with compressed air, and the methods of disposing of the water are now getting to be quite generally understood. One thing very soon learned is that an air receiver will not get rid of the water.

Fig. 1 is a snapshot of an air receiver outside the compressor house of one of the New York State barge-canal contracts. The compressor was electrically driven by current generated at one of the falls of the upper Hudson. There was no aftercooler and the engineer said that he opened the drain cock at the receiver every day or two but did not get enough water to pay for the trouble. About a quarter of a mile along the pipe line, however, there was an enlarged and depressed chamber formed in the line; here the water could be drawn off in considerable quantities, and about another quarter of a mile further along the line, where most of the air was used, there was a locomotive-type steam boiler which served the double function of receiver and separator, and here the remainder of the water was taken care of.

All normal atmospheric air when compressed to, say, one-sixth or one-eighth of its volume and cooled to its initial temperature contains more water than is sufficient to saturate it, the surplus of moisture still remaining in the air in a cloudy condition, and it does not suddenly and immediately drop out of the air any more than a cloud in the sky drops as soon as it is formed.

Fig. 2 shows a highly efficient aftercooler and its attached air receiver at the Rondout siphon contract of the T. A. Gillispie Company on the new water supply for New York City. The air here enters the receiver low down and is dis-

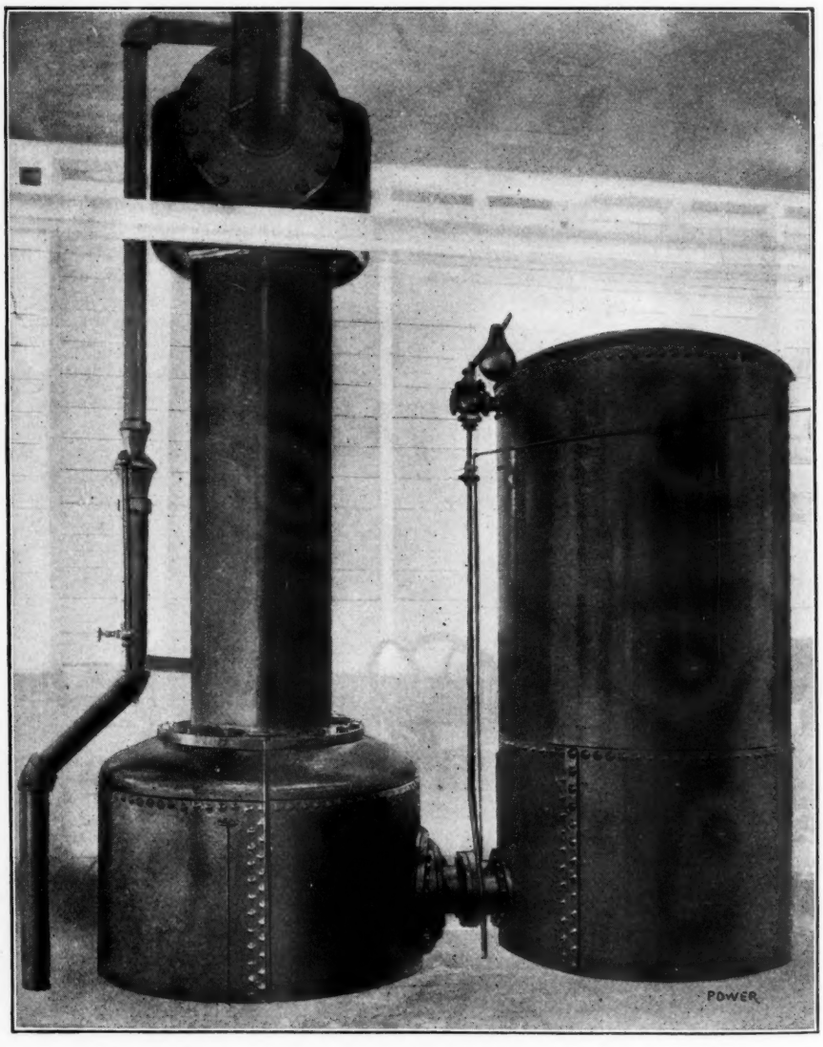


FIG. 2. AFTERCOOLER WITH RECEIVER ATTACHED

charged near the top on the side not visible, but if it had been connected the other way it would have made no particular difference; it did not get rid of the water.

In the horizontal main pipe line, taking the air delivery from all the compressors, was placed a drum about four times the diameter of the pipe and perhaps double the diameter in length, with a number of vertical baffle plates attached alternately to the top and to the bottom. The air passing in at one end and out at the other would zigzag between the plates, wetting them as it went, and the water accumulated at the bottom had to be drawn or blown off as often as necessary.

When the air is in the supersaturated condition which results from the aftercooling it is not difficult to separate the surplus water, but some means must be provided, or at least more time must be allowed than it has in passing through the receiver. Any effective steam separator is good also for wet air. Even as the air flows along a horizontal pipe it wets it as it flows and the water may be drawn off at the low places. If it is not drawn off it is carried along and is found in the exhaust of the tools or machines operated. Water when in this condition, wetting and clinging to the surface it may come in contact with, is easily taken care of.

The necessity of providing some means of taking the water out of the air after it is condensed and released seems to be the one thing in the circle of air-compression operations now most often neglected. Whatever the apparatus or arrangement employed for the purpose, it would seem to be certainly worth while to adopt it for only slight initial cost will be involved; there is no expense in the work of separation.

FRANK RICHARDS.

New York City.

On Being One Sided

I read with interest the editorial in the June 27 number entitled "The New York Edison Company's Advertisement" and containing a letter signed I. A. of E. The fact is that we want the Edison company's advertisement, also such articles as that by George P. Gilmore in the June 20 issue. When two sets of men differ in opinion there is no gain for either in trying to dodge or suppress the arguments of the other. The mistaken party will provide its own undoing if given the opportunity. The trick is to meet opposing arguments with still stronger ones.

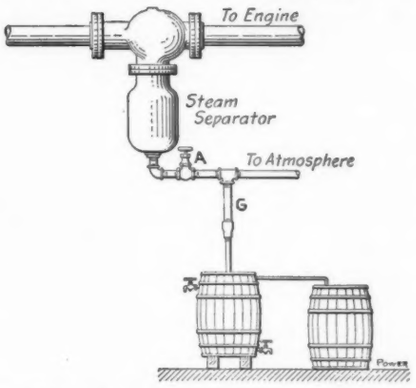
No engineer, superintendent or owner with any experience could be induced to electrify his plant by reading Mr. Gilmore's article for the simple reason that his claims are too extravagant.

L. JOHNSON.

Exeter, N. H.

Still for Drinking Water

In response to Mr. Eldred's inquiry in the June 6 number, I submit the accompanying sketch which illustrates the manner in which I obtain an ample supply of pure water for drinking purposes.



ARRANGEMENT FOR COLLECTING DRINKING WATER

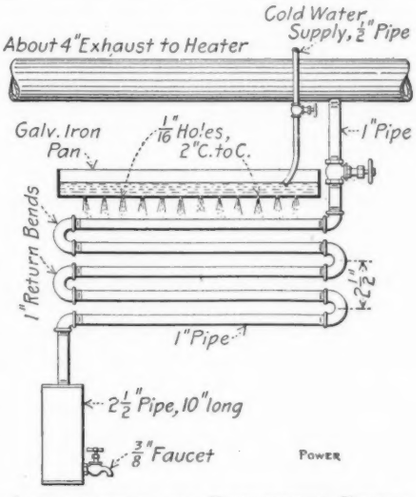
The valve *A* is throttled down so that it just a little more than drains the separator. For tanks I use oil barrels that have first been burned out so that the inside is lined with a coating of charcoal.

In another plant where I worked, one of the returns was tapped and the water of condensation was piped to a metal storage tank. In this manner ample drinking water was obtained for 50 employees.

S. J. PERRY.

Dover, Idaho.

In the June 6 number, E. G. Eldred inquires how to construct a condenser so as to obtain about two gallons of good drinking water per day. The accompanying sketch illustrates the construction of one which may be suitable to his needs. The condensing coil may be placed in any convenient location. If the heater is of the open type, tap into the exhaust line before it reaches the heater.



ARRANGEMENT FOR CONDENSING DRINKING WATER

If the water tastes too flat, put a little salt into it, or, better still, put in some raw oatmeal, which will make a most refreshing drink.

WILLIAM NOTTBERG.

Kansas City, Mo.

Asleep on the Job

The editorial in the June 13 issue "Gathering Them In" and the letter "Asleep on the Job," by Mr. Hyde, are two interesting sketches. Many engineers are asleep; they do not or cannot realize the conditions that exist today. Unless the man who calls himself an engineer will keep abreast of the times he will fall by the wayside.

Just lately I observed a case in point. The engineer was economical of packing and waste and oil, but he slept alongside his leaky balanced flat-valve engines until something happened. He thought that nothing could be said against these machines as they were running smoothly —leaky machines generally do run smoothly—and if anyone had hinted at leaky valves he would have felt insulted. Many plants are being closed down because of just such conditions. The engineer makes no test; he does not know whether the boilers are at fault or the engine. The plant runs on, as the proprietor depends upon his engineer, who has gone to sleep. Then comes the outside power man, and before the engineer wakes up and can produce any records a contract has been signed.

I recently met a case where a boiler test was desired by the owner. I looked over the plant and found two nice-running "thieves" bleeding the cash drawer—a balanced flat-valve and a round-valve engine. No attention had been given to the take-up of wear on the valves, and I could easily see why a boiler test was wanted. The poor boilers catch the blame. It is a good plan, however, to start with them and follow the steam pipe; you will surely find some "niggers in the woodpile."

As Mr. Hyde says, the isolated-plant engineer must keep awake; this is the whole story. Associations and organizations will do no good if they fail to first awaken a lot of us who are sleeping.

Look the plant over and see if you have a similar case. Watch out or the central-station man will get you! The engineer should know what he is doing by actual trial and by keeping records, and the records should be compared with those of other plants. The central-station man does not approach the fellow who runs a plant on a systematic and scientific basis—the man who can tell the manager what current cost for the same month of last year. This fellow holds his job as he is earning dividends for his company. Many men simply burn coal without knowing the cost or

results; if the manager should ask how much ash the coal contained they could not give a good guess. This may seem as if I were coming down hard, but it does not hurt to tell facts. Unless these facts are seen by many engineers I am afraid there will be a glut in the market of engineers or should I say throttle turners?

C. R. McGAHEY.

Baltimore, Md.

Unnecessary Clearance Loss

Referring to my letter in the April 25 issue entitled "Unnecessary Clearance Loss," the illustration shows an engine of the Corliss type in which the exhaust valves would come in such a position as to make it impossible for the openings leading to the relief valves to be in the position shown. The engine referred to in this letter was an Atlas four-valve, in which the valves and ports are in the heads; this allows the openings for the relief valves to be on the bottom, as shown, the Atlas being about the only engine in which it would be possible to place the relief valves in this position.

S. KIRLIN.

New York City.

Writing for the Technical Paper

Extended discussion of a particular theme, unless each contribution thereto opens up a new and valuable line of argument, is very apt to grow tiresome to the reader; hence the writer will but briefly approach the "writing" subject for a second time. It would appear, however, that Mr. Williams, in the issue of June 20, commenting upon the writer's reply to his former communication, is laboring under a slight misapprehension of its full intent and meaning.

The exact explanation may be summed up by taking the four words used on the editorial page of this same issue, namely, "Opportunities for Self Advancement"; the writer inferred one of them to be a betterment of one's self, and whether the man is 16 or 60, it is never too late. Mr. Williams notes that the writer's remarks are applicable when one has a "typewriter, an Encylopedia Britannica, and a Century and a Funk & Wagnalls' dictionary." This is wrong; they apply at the youthful stage, when we learn to think for ourselves, and they never end while we live.

A typewriter may assist in making neat and legible copy, but in the majority of cases handwriting will answer. It takes brains, intelligence and common sense to compile a contribution really worth while, and the machine lacks these features. As for the encyclopedia, POWER, week in and week out, is for the engineers about the best to be found, and for practical, uptodate information has got the one mentioned "done to death." As for the dictionary to be "obtained for a trifling sum," put POWER to this use again, and in company with the quarter dictionary it is a combination hard to beat.

Mr. Williams makes notation of the "literary monument" and "the new writer who has neither time nor patience." The former in the technical field is not looked for; the man we would like to hear from is he who follows "the papers" and recalls contributions to which this can be applied determinately. There is a wide call between "practical" and "literary."

A man who has "neither time nor patience" will not take proper care of his plant; he is usually the fellow who spends half his time in "resting" and the other half in bemoaning that he "isn't appreciated." If this man has no time or patience to make good in his work and to better his condition, he surely is not the man to tell the other fellow "how to do it," and this is what POWER is after.

The writer will not intrude again with this topic, and for conclusion offers the following advice—it may be compassed in three words—do it right! Make the opportunity for self-advancement bear as much fruit as the opportunity to legitimately earn a dollar. Understand what you read, and remember that the other fellow must understand what you write.

JOE SMART.

Los Angeles, Cal.

Sizes of Turbine Steam and Exhaust Pipes

I was much interested in the letters of Messrs. Neilson and Kent, discussing the subject of sizes of exhaust pipes, brought about by the publication of my curves in POWER for February 21.

Referring first of all to Mr. Neilson's letter in the issue of March 28, he states that my curves are not based on correct principles, nor are they truly scientific. I agree with him entirely that the development of this chart is not based on such a careful study of conditions as his formula, but I think the curves are more commercial than his formula. Mr. Kent had already raised one question I had in mind when studying Mr. Neilson's formula, and that is the length of pipe; but in addition to this another point is overlooked which in the writer's mind is much more serious, the layout of the piping. There should surely be some correction factor for all elbows, bends, etc. Again, this factor should be further split up, covering the nature of these bends; for instance, it is obvious that a greater drop with a sharp bend or tee is expected than with an easy bend.

One other point, to go into this matter in a truly scientific manner, is the nature of the inside of the pipe. It is obvious that in any comparatively small piping the friction in a rough cast-iron pipe must be perceptibly greater than in a smooth copper pipe.

Mr. Kent has already raised the question of the nature of the turbine exhaust, whether this be correctly coned and whether it be tangential to the casing or radial, so that while Mr. Neilson's formula is, I acknowledge, scientific, it is not by any means complete.

If we take Mr. Neilson's formula and add to it a few more factors, taking care of all possible contingencies, we will have a formula both unwieldy and, I consider, impracticable, for reasons I will endeavor to explain. Supposing we design an exhaust pipe to pass 10,000 pounds of steam per hour at a 27-inch vacuum. How often in practice will this pipe pass 10,000 pounds of steam per hour at a 27-inch vacuum? If we design our pipe on truly scientific principles, all our theories are knocked on the head for a greater percentage of the time at which this pipe is operative. When we design our turbine for given conditions, we begin by assuming that our actual load will be somewhere near this amount, but anyone who has had experience in central-station work knows that if the machine was originally designed for 3000 kilowatts, that machine operates at exactly 3000 kilowatts for a very small percentage of the time. Mr. Neilson claims that an exhaust pipe designed with the velocities given in my curve, namely, 400 feet per second, will not work well in practice. I have been reviewing a few actual cases where velocities have varied anywhere from 200 to 800 feet per second, but there has been no indication of serious troubles due to velocities being too high or too low.

When I published my curves I did not expect all engineers to agree with me that a velocity of 400 feet per second was best, but it is a very easy matter to interpolate from these curves for any other velocity that it is desirable to employ. If I had considered for a minute that the curves as published were the correct and only proper sizes to use, I would not have given the velocity, entropy, etc., on which the curves were developed, and I cannot help feeling that the curves as published, used with the discretion expected of any engineer, will work as well in practice as a long formula which, when figured out, is only good for a condition existing for probably only 2 or 3 per cent. of the time the pipe is in service.

W. J. A. LONDON.

Hartford, Conn.

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POWER

Knowledge is Power

In a New England city a realty company erected two eight-story factory buildings which were rented with heat and power for manufacturing purposes. No engines were installed as the management was convinced by the agent of the central station that at its flat rate for electrical energy, one and three-fourths cents per kilowatt-hour, the realty company could not afford to generate current for its tenants. After a year it was evident that no dividends were probable under the circumstances and a committee was chosen from the board of directors to find the leak. The chairman of this committee got permission to consult his engineer. The treasurer's books were opened to the engineer who, after a thorough examination, said: "You are not making money because you are paying to the central station what should be your profit in this business. Steam must be used all the year round and during six months of the time so much is needed that an engine large enough to generate all of the current used will cost you for fuel for operation practically five per cent. of the amount burned if the exhaust steam is used for heating the buildings. The additional cost of operation will be the wages of an engineer, the interest on the investment, depreciation and taxes.

"With a properly designed plant current can be made for less than is being paid for it now during the time no heating is necessary and almost for nothing so far as fuel is concerned during cold weather, for the engineer will more than save his wages by simply being on the job and seeing that intelligent fireroom practice is followed."

After some deliberation the board of directors adopted the suggestions embodied in the remarks of the engineer.

At the end of the first month of operation, which was in the early summer, when but little steam was required for heating and when operating conditions were not the most favorable, the expense sheet showed that the investment was paying interest at the rate of twenty-four per cent.

With an example of the possibilities of the isolated plant so plainly showing that the central station cannot compete with it under any ordinary condition of service, there is no reason why the engineer should fear the encroachment of central-station service.

Wherever comparative tests have been made on an honest, intelligent basis the results have usually shown the advantages of the isolated plant. If the engineer knows what he is doing and what it costs to do it, no outsider will be able to convince the owner of the little plant that central-station service is cheap.

But if he does not know these things the trained salesman will sweep him off his feet with a flood of misinformation that he cannot refute.

At no time in the history of steam-engine operation has the phrase "knowledge is power" been more fitting than now. It is the engineer's business to know, and where he knows he is safe.

Marine Engineering

When visiting a modern power house one is often impressed by the excellent features of design embodied in the general layout. But let the same person take a trip through the engine room of one of our large transatlantic liners and the stationary plant will be entirely eclipsed by the more intricate design of the floating plant.

Without attempting to detract from the glories of the designer of stationary plants, it may be truthfully said that the problem of the marine engineer is decidedly more complex. In stationary practice the designing engineer is concerned chiefly with meeting the conditions of operation, space being a secondary consideration, except in special cases. On the other hand, in marine practice, while the operating conditions are less variable, space and weight are factors of paramount importance. Not only is it necessary to keep the weight within certain limits but it must be so distributed as to meet both structural and displacement requirements. As for space, every available foot is utilized and this requires much planning and scheming on paper before the actual construction begins. This applies especially to the piping. An idea of the compactness of the equipment on a modern liner may be gained from the fact that the main engine room of the "Olympic" (containing many of the auxiliaries) covers only about 0.25 foot of floor space per horsepower.

Another important feature in marine design is continuity of service. There

are no spare units to be thrown in, as are usually provided in land practice, and all repairs have to be made with the limited facilities at hand.

In view of the many fine problems in design offered by marine engineering it is deplorable that this profession should have declined to such an extent in this country, all large vessels, excepting Government vessels, now being built on the other side of the Atlantic. The cause of this condition is too well known to need comment, and, moveover, there appears to be no relief ahead. Meanwhile American engineering talent lies dormant in this field.

Going over the Chief's Head

It has been stated time and again that the efficient, capable man will always find a position that measures up to his ability, but the case cited will show where this contention did not hold good.

A POWER representative recently called at a small steam plant which was operated by an intelligent young man whose conversation made it appear that he was capable of handling a much larger installation. He expressed the wish that he could obtain a better position.

A few days later this man's case was mentioned to the master mechanic of a large manufacturing company. "He is a good all-round man," said he, "but he does not know his place; he goes over the head of his department and causes almost constant trouble. He has worked for me, but I had to let him go because of this one serious fault."

It is not reasonable to expect that a chief engineer will retain an assistant who is continually taking his grievances to the general manager or president, thereby going over the chief's head, and the man who does so can expect dismissal sooner or later. The chief engineer of a plant is its official head. If an assistant engineer thinks he is being ill treated, it is better to take the matter up with the chief than to ignore him and go to someone higher up.

Looking at the matter in another light, going over the head of a chief smacks of snobbishness; it also makes it appear that a square deal cannot be had from him. There are but few chief engineers who are not interested in their assistants, and there have been hundreds of them who have put themselves out to assist their subordinates.

One chief engineer adopted the plan of asking his assistant's advice about various changes to be made, though he had previously formulated a plan and merely gave the assistant an opportunity of expressing his ideas. If they agreed with the chief's plan they were adopted and the assistant then knew that his plan was a good one. This practice soon aroused a general feeling of fellowship in the plant, and the men knew that the chief would fairly adjust any grievance they might have.

Central Station Service

There is an old saying, "Do not put all your eggs in one basket" and a modernization of it, "Put all your eggs in one basket and watch that basket." No matter how well designed or constructed a power plant may be, it is practically impossible to supply energy one hundred per cent. of the time, although this figure may be closely approximated. The weakest link in the operating chain reveals itself, now at one point, now at another, and even the complete duplication of plant and transmission system has not proved itself immune from that unforeseen and inexplicable perversity of inanimate objects which results in their simultaneous shutdown. Often these shutdowns are comparatively trivial, the current supply being only interrupted for a fractional part of a second, but, strictly speaking, any interruption of service is inexcusable. There is one daily report which should reach the highest official of every concern operating a power plant. It should give the time and duration of every incident which caused the operating potential to drop below the normal, even though it is only a flicker of the lamps; and should then be tabulated and compared with past records. The daily-shutdown report has been the spur under which the steel mills have attained their records of production.

How the Empire State Classes Engineers

While the united engineers' societies of New York City are agitating for the revision of the proposed charter in Section 792 so as to provide for real examination of engineers by engineers the printed copies of the charter as it is before the legislature have appeared. The sections between 790 and 800 have been left out altogether, but back in Chapter XV, which deals with the Police Department, appears the following:

"The department shall have general jurisdiction over and supervision and regulation of pawnbrokers, hawkers, peddlers, junk-shop keepers, junk boatmen, cartmen, dealers in second-hand merchandise, intelligence-office keepers and auctioneers; and the inspecting, testing and issuance of license certificates for steam boilers, and the issuance of certificates of qualification for the care and control of steam boilers, and for the purpose of ascertaining the qualification of applicants for such certificates the commissioner may detail a board of examiners to conduct examinations."

Rotundity, Not Type of Joint the Essential in Shell Boilers

The discussion at the recent meeting of the American Boiler Manufacturers' Association of the question, "Will the present type of butt and strap joint fail frequently in the future as the lap seam has in the past?" led to the conclusion which POWER has several times advanced, that the butt and strap joint will not be a panacea for joint troubles. The cracks which lead to the failure of lap joints and several of which have appeared in butt-strapped joints are due to the repeated bending of the metal about a fixed line. Under pressure the boiler shell tries to become circular. If it is not circular to start with, there will be some movement every time the pressure varies, and if the movement is concentrated upon some particular line a break will finally occur just as a wire will break when it has been bent back and forth a sufficient number of times around the same point.

With the lap seam it is impossible to make a boiler circular in the first place; with a butt-strapped joint the shell may be made truly circular so that there need not be movement. There was some talk in the discussion about the effect of having a part of the circumference so much thicker and heavier than the rest, but we do not see that there will be any tendency to bend the thin single sheet around the edge of the thicker double-strapped portion except by unequal heating if the structure is round to start with.

The advantage that the butt-strapped joint offers is that with it the shell may be made round. If the shell is allowed to vary from a true circle the use of a butt joint will not save it.

Safe Boiler Construction

Among all the boiler failures during recent years there have been but three which were of the butt-and-strap construction. While not all of the other failures have been due to the lap joint, such a large proportion have failed at the seam that it proves that form of joint to be unsafe. None of the butt-and-strap failures were explosive, and were all due to the same cause that makes the lap seam dangerous; the shells were not cylindrical and the changes of pressure permitted the same destructive bending in the sheet that takes place in the lap-seam form of construction.

With the present high standard of excellence in boilermaking machinery and the available skill to operate it, it is possible to make boiler shells with butt joints which are truly cylindrical and which will not be affected by those causes which will in all cases eventually crack the shells of all lap-seam boilers.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Power of Current Waterwheel

How much power can be derived from a wheel of the ordinary paddle or waterwheel construction anchored in an open stream something on the principle of an undershot waterwheel; the size to be 14 feet diameter by 20 feet long; the velocity of stream 7 miles per hour?

A. P.

According to the experiments of Poncelet and others, the best effect is obtained when the wheel is immersed to one-fourth of its radius. This is 40 per cent. of the theoretical energy of the cross-section of the water intercepted. The diameter of the wheel being 14 feet, one-fourth of its radius would be 21 inches. With this immersion for a wheel 20 feet long, the cross-sectional area of intercepted current would be 35 square feet.

A velocity of seven miles per hour is 10.26 feet per second; hence the wheel would intercept $35 \times 10.26 = 359.1$ cubic feet or 22,443.7 pounds of water per second. The energy represented is $\frac{22{,}443.7 \times 10.26^2}{64.4} = 36{,}732$ foot-pounds per second $= 66.78$ horsepower. The greatest effect obtainable being 40 per cent. of the energy in the water, the power obtainable from the wheel would be 40 per cent. of 66.78 horsepower, or 26.71 horsepower.

Flow of Superheated Steam

Inquiries are often made regarding the loss of pressure in pipe lines conveying superheated steam, particularly where there are a number of elbows and other connections. In the use of saturated steam such a loss is known to exist, but what happens in the case of superheated steam? The temperature naturally decreases, due to radiation but is there any drop in pressure before reaching the point where the steam cools to same temperature as the boiler-pressure steam?

Various papers have been read and discussed relative to the merits of superheaters and the use of superheated steam, but as far as I can ascertain no one has given any specific information on this point.

A. H.

So far as is known there are no reliable data relating to the loss of pressure in superheated steam flowing through pipes. There must be a drop of pressure sufficient to overcome the resistance of flow. This would be probably less with superheated steam for the same velocity on account of the less density of the medium, but might be more for the same weight delivered on account of the greater velocity required.

Gage Glass and Water Level

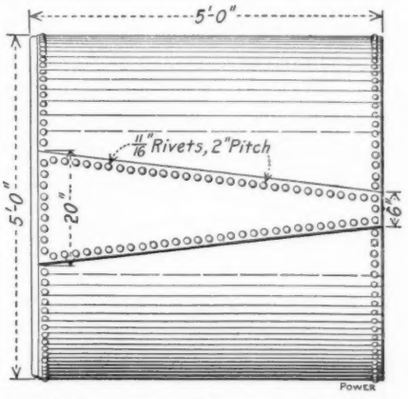
Why does the water glass not show the true level of water in the boiler?

W. L. B.

The water gage does show the true level of the water in the boiler if it is properly connected and the openings are of sufficient size and unrestricted.

Efficiency of Diagonal Seam

A 60-inch shell built of 5/16-inch plate having a tensile strength of 60,000 pounds per square inch has a single-riveted patch for its entire length. The patch is 20 inches wide at one end and 6 at the other. The rivet holes are 11/16 inch in diameter and the pitch is 2 inches. Assuming the rivets to be of steel and



PATCH WITH DIAGONAL SEAMS

the efficiency of the joint to be 41 per cent., what increase in efficiency is obtained by the patch seam being slightly diagonal to the axis of the shell?

E. L. D.

To find this in a simple manner multiply the length of the patch seam in inches by 41, the efficiency of the joint, and divide the product by 60, which is the length in inches measured along a line parallel to the axis of the cylinder. Thus, as the patch seam measured along the rivet centers of the diagonal seam is 60.4 inches,

$$\frac{60.4 \times 41}{60} = 41.27 \text{ per cent.}$$

the efficiency of the diagonal seam. There is a gain of 0.27 per cent. in efficiency.

Dangerous Fire Cracks

How can I tell when a fire crack is dangerous?

E. H. C.

Fire cracks are dangerous when they extend beyond the rivet hole into the plate and when leaks, if any, cannot be stopped.

Grooving in Boiler Sheets

Where is grooving found in a vertical and locomotive boiler?

T. P. T.

Grooving usually occurs near to and parallel with a rigid seam.

Pitch at Girth Seam

Why is it that in a double-riveted lap joint the rivet in the inside row next to the girth seam has a greater pitch than the rest of the rivets?

C. G. F.

Double-riveted lap seams have a wide pitch next to a girth seam because the rivets in the two rows are staggered and therefore in starting a seam the pitch on one row must be wide. The spacing on the outer row is kept uniform to permit calking. The stiffening effect of the girth seam more than compensates for the lack of a one-half rivet at this point.

Safety Valve Areas

How are safety-valve areas determined?

S. V. A.

The formula used by the Board of Supervising Inspectors of the United States for the area of safety valves is

$$a = 0.2074 \times \frac{W}{P}$$

where

a = Area of safety valve in square inches per square foot of grate surface;

W = Pounds of water evaporated per square foot of grate surface per hour;

P = Absolute pressure in pounds per square inch.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Water Cooling

By F. E. Matthews

Since the specific heat of water is unity, the number of heat units to be extracted in order to produce a given drop in temperature of a given quantity of water is found by simply multiplying the weight in pounds by the range cooled through in degrees.

If, for example, 20,000 pounds of water is to be cooled one degree, 1000 pounds 20 degrees, 4000 pounds 50 degrees, or, in fact, any number of pounds through a range of temperature that will give a product 20,000 pound-degrees, just 20,000 B.t.u. will be required for the cooling.

One United States gallon of water at 62 degrees Fahrenheit weighs 8.336 pounds. The cooling of 20,000 gallon-degrees will accordingly require

$$8.336 \times 20{,}000 = 166{,}720 \textit{ B.t.u.}$$

If the cooling is accomplished in 24 hours the amount of refrigeration required will be

$$166{,}720 \div 288{,}000 = 0.5789 \textit{ ton}$$

If done in one hour the equivalent rate per 24 hours will be 24 times as great, or

$$0.5789 \times 24 = 13.893 \textit{ tons}$$

Table 1 shows the amount of refrigeration required to cool 1000 gallons of water per minute, hour and 24 hours through different ranges of temperature. If 1000 gallons of water be cooled 50 degrees in one hour the equivalent cooling effect per 24 hours will be 10 times the value given in the table for 5 degrees or 34.733 tons; if 53 degrees, 10 times the value for 5, or 34.733, plus that given for 3, or 2.0840, making 36,817 tons, must be taken.

TABLE 1. REFRIGERATION DUTY IN TONS PER 24 HOURS REQUIRED TO COOL 1000 GALLONS OF WATER

Degrees Cooled	1000 Gallons Cooled per			Degrees Cooled	1000 Gallons Cooled per		
	Minute	Hour	24 Hours		Minute	Hour	24 Hours
1	41.68	0.6946	0.02894	21	875.28	14.5879	0.60778
2	83.36	1.3893	0.05789	22	916.96	15.2824	0.61672
3	125.04	2.0840	0.08682	23	958.64	15.9770	0.65564
4	166.72	2.7786	0.11577	24	1000.32	16.6716	0.69456
5	208.40	3.4733	0.14471	25	1042.00	17.3664	0.72352
6	250.08	4.1679	0.17364	26	1083.68	18.0612	0.75248
7	291.76	4.8646	0.20259	27	1125.36	18.7598	0.78142
8	333.44	5.5590	0.23154	28	1167.04	19.4584	0.81036
9	375.12	6.2519	0.26048	29	1208.72	20.1491	0.83931
10	416.80	6.9466	0.28942	30	1250.40	20.8399	0.86826
11	458.48	7.6412	0.30836	31	1292.08	21.5379	0.89721
12	500.16	8.3358	0.34728	32	1333.76	22.2360	0.92616
13	541.84	9.0306	0.37624	33	1375.44	22.9289	0.95510
14	583.52	9.7292	0.40518	34	1417.12	23.6218	0.98404
15	625.20	10.4199	0.43413	35	1458.80	24.3147	1.01298
16	666.88	11.1180	0.46308	36	1500.48	25.0076	1.04192
17	708.56	11.8109	0.49202	37	1542.16	25.7023	1.07086
18	750.24	12.5038	0.52096	38	1583.84	26.3970	1.09980
19	791.92	13.1985	0.54990	39	1625.52	27.0918	1.12874
20	833.60	13.8933	0.59884	40	1667.20	27.7866	1.15768

Wort Cooling

Table 2 shows the amount of refrigeration expressed in tons per 24 hours required to cool 100 barrels of water per hour and one barrel per minute through different ranges of temperature To apply this table to wort cooling multiply the number of barrels of 31 gallons by the specific gravity of the wort and this product by the specific heat of the wort corresponding to the specific gravity.

To cool 40 degrees 100 barrels of wort per hour having a strength of 12 per cent., for example, it is found from Table 2 that the refrigeration required to cool a like amount of water is 86.18 tons. If the specific gravity of the wort is 1.049, the weight of the wort cooled will be 1.049 times as great as for water, but if the specific heat is only 0.916, the refrigeration per pound will be only 0.916 times as great. The product of these two factors, 0.9609, shows that the amount of refrigeration required to cool a given quantity of wort of 12 per cent. strength is 0.9609 times as great as for the same quantity of water, or in the above example of 100 barrels per hour,

$$0.9609 \times 86.18 = 82.80 \textit{ tons}$$

TABLE 3. PRODUCTS OF SPECIFIC GRAVITY AND SPECIFIC HEAT OF WORT OF DIFFERENT PER CENT. STRENGTHS

Strength	Product	Strength	Product
8	0.9742	15	0.9499
9	0.9741	16	0.9463
10	0.9665	17	0.9426
11	0.9631	18	0.9390
12	0.9609	19	0.9353
13	0.9571	20	0.9320
14	0.9536	..	.....

Refrigeration required to cool wort = that required to cool equal quantity of water, multiplied by the above "product" corresponding to strength of wort

$$\frac{\left(\begin{matrix}\text{Bbl. of wort per hour: 100}\end{matrix}\right)\left(\begin{matrix}\text{Gal. per bbl.-wort: 31}\end{matrix}\right)\left(\begin{matrix}\text{Wt. water per gal.: 8.34 lb.}\end{matrix}\right)\left(\begin{matrix}\text{No. degrees F. cooled: 40}\end{matrix}\right)\left(\begin{matrix}\text{Specific gravity of wort: 1.049}\end{matrix}\right)\left(\begin{matrix}\text{Specific heat of wort: 0.916}\end{matrix}\right)}{\text{(B.t.u. per hour equivalent to a ton of refrigeration per 24 hours: 12,000.)}} = \left(\begin{matrix}\text{Rate of cooling. Tons per 24 hr., 82.80}\end{matrix}\right)$$

TABLE 2. REFRIGERATION DUTY IN TONS PER 24 HOURS REQUIRED TO COOL BARRELS OF WATER

Degrees Cooled	100 Bbl. of 31 Gal., per Hour	1 Bbl. of 31 Gal., per Min.	Degrees Cooled	100 Bbl. of 31 Gal., per Hour	1 Bbl. of 31 Gal., per Min.
1	2.1545	1.2927	21	45.2445	27.1467
2	4.3090	2.5854	22	47.3990	28.4394
3	6.4635	3.8781	23	49.5535	29.7331
4	8.6180	5.1708	24	51.6988	31.0248
5	10.7725	6.1635	25	53.8625	32.3175
6	12.9270	7.7562	26	56.1370	33.6102
7	15.0815	9.0489	27	58.1715	34.9029
8	17.2360	10.3416	28	60.3260	36.1956
9	19.3905	11.6343	29	62.4805	37.4883
10	21.5950	12.9270	30	64.6350	38.7810
11	23.6995	14.2197	31	66.7895	39.0737
12	25.8494	15.5124	32	68.9440	41.3664
13	28.0685	16.8051	33	71.0985	42.6591
14	30.1630	18.0978	34	73.0530	43.9518
15	32.3175	19.3905	35	75.4075	45.2445
16	34.4720	20.6832	36	77.5620	46.5372
17	36.5265	21.9759	37	79.7165	47.8299
18	38.7810	23.2686	38	81.8710	49.1226
19	40.9355	24.5613	39	83.9255	50.4153
20	43.0900	25.8540	40	86.1800	51.6581

The same result might have been obtained from Table 1 by first reducing the quantity in barrels to gallons, or di-

rect from the equation on page 152 in which for clearness the previous values have been substituted.

This expression when applied to wort cooling expressed in barrels of 31 gallons cooled per hour becomes:

$Tons = 0.021545 \times (t - t_1) \times s.g. \times s.h.$

in which

$(t - t_1)$ = Range of temperature cooled through (40 degrees Fahrenheit);

$s.g.$ = Specific gravity of the wort (1.049);

$s.h.$ = Specific heat of the wort (0.916).

These values substituted in the above equation give tons per 24 hours equal 82.80 as above.

An Absorption Kink

By H. J. Macintire

The "old man" had been an operating engineer for a number of years, and he knew pumps and engines almost by heart, but the company decided to utilize its exhaust steam and make ice by the absorption method. From that time the "old man's" troubles began. He was nervous, and when things went wrong he got excited; after the absorption plant began to be operated he was excited most of the time. How could that thing which did not move do work? The compression machine was easy, for it was similar to any compressor or a steam engine in its operation, but the absorption machine only had one thing that moved, the steam pump which pumped what they called strong aqua from the absorber to the large tank with steam coils which they called the generator. He could not make head or tail of the whole matter, and so the day engineer put marks on the glass gages and told the "old man" to keep the levels constant at the marks. Occasionally, however, he would still mix things up a little.

The cooling water used necessitated a galvanized-iron pipe for the coils, and the zinc was dissolved out by the ammonia; this formed a deposit on the gage valves and tended to clog them. The gage valves on the generator stuck during the "old man's" watch, and when he was relieved by the day man the generator was almost empty and the absorber was full to the top. The day man then explained that it is not likely that more than one valve will get choked up at a time, and that the other gage glasses will give a check on the generator. Any unusual rise in the level of the liquid in the condenser or absorber should be investigated and the cause located.

Gage-cock valves may be cleaned while operating by pushing back on the ball by means of a fine wire. The aqua will then start out, removing the sediment by the velocity of flow, and the ball will automatically close again.

LETTERS

Clearance in Compressors

I read the article by E. A. Murphy in the June 27 issue of Power with interest. I would like to know by what computations or actual comparative results Mr. Murphy arrives at the conclusion that a compressor having a smaller clearance would superheat the gas more than would the same compressor with a larger clearance, working under the same conditions of suction and head pressures. It would seem to me that the superheat in both cases would be the same.

Mr. Murphy states that "the cylinder walls of a no-clearance compressor will superheat the gas more and thereby reduce the capacity to a greater extent than will a compressor with clearance reduce the apparent capacity," but fails to show by comparative data, or a more detailed explanation, the correctness of his statement.

The apparent advantage of the practice of ice-machine builders to reduce the clearance to the minimum seems obvious. If a compressor is working, say, against a head pressure of 200 pounds, the suction pressure being 20 pounds, and has a 5 per cent. clearance, the gas that would remain in the clearance space, at 200 pounds, at the termination of the stroke, would expand at the return stroke and would, at one-quarter of the return stroke, fill the cylinder with gas at 20 pounds pressure. Thus it may be seen that this would apparently reduce the working capacity of the compressor by fully 25 per cent. Compressors with larger or smaller clearances would reduce the working capacity in like proportion.

To prevent this apparent loss of capacity, compressor builders are endeavoring to reduce clearance space to the minimum consistent with safety of operation.

One compressor builder accomplishes this by injecting a charge of oil at every stroke, in order primarily to lubricate the compressor walls and secondarily to fill the clearance space with oil at every stroke to make the discharge of all the gas in the compressor possible.

Another one builds compressors with practically no clearance, using the discharge-valve housing as a relief valve, with an effective area equal to the bore of the compressor, calling it a safety head. This construction is used to prevent serious damage to the machine in case liquid should be drawn into the compression space.

Compressors with small clearance are at the present time generally conceded to be the most economical, but most of us are willing to change our ideas on the subject if Mr. Murphy can demonstrate by actual results that his large clearance, lower-superheat theory is correct.

Victor Bonn.

New York City.

Preventing Red Core in Ice

In 1885 I was assistant engineer in an ice factory. The plant consisted of one 10- and one 5-ton Boyle machine and for the three years that the plant was operated there was not a block of ice made with a red core, because the steam cylinder was lubricated with beeswax instead of oil. Although the one charcoal filter on each machine could not take out all the wax that came over with the water, the small amount that was left separated when the water was frozen solid and floated to the top. The 1¼-inch pipe carrying the distilled water from the cooling coil to the charcoal filter was about 50 feet long, and of common black iron not galvanized. The storage tank was galvanized, but the coil inside the tank that carried the ammonia was not. The iron pipes rusted, yet they caused no red in the ice.

Three years later a 20-ton Consolidated ice machine was installed with Corliss valve gear. As the erector informed the purchasers that wax would not lubricate the steam valves, a dark-colored oil was used, and in three months' time a red core began to show in the ice and continued for many years. At times it was so bad that it was necessary to chip 10 to 15 pounds out of the bottom of each block, as it was unsalable.

To make ice free from a red core and yet use oil for lubricating the steam cylinder, the exhaust steam on its way to the condenser must first pass through a separator and then through a coke filter. The coke should be renewed every season. At the condenser the relief pipe should blow slightly at all times, thus getting rid of the uncondensable gases and preventing air from being drawn in if a slight vacuum should be formed. The distilled water after leaving the cooling coil should pass through a quartz filter, the quartz to be in pea and nut sizes laid alternately about 18 inches thick. From the quartz filter the water passes through a charcoal filter and then to the storage tank. After running a season the quartz should be taken out. It will then be found to be oily and discolored, especially the pieces nearest the bottom, thus showing the work done in separating the oil from the water. Charcoal is useless for this purpose. Quartz takes away the dull white appearance and adds a bright sparkling look to the ice.

The quality of cylinder oil is a great factor. I always use a clear oil rather than a dark one, for even with all the above precautions a slight discoloration floats to the top of the block. I have examined blocks when nearly frozen and seen these little particles slowly floating up to the surface. They are so trifling that the dip in the thawing tank dislodges them.

E. Bronstorph.

Kingston, Jamaica, B. W. I.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

"Addistometer" Stroke Reading Instrument

The quantity of water delivered by a pump at each revolution varies according to the length of the piston strokes. To determine the length of all the strokes of a piston of a pump is only a matter of computing the cubic contents of the liquid pumped during the time in which such strokes are made. The "Addistometer," or stroke-measuring device, records the length of each stroke of the piston. It is shown in a sectional view in Fig. 1. The roller ratchet arrangement which is used is shown at *A*.

Fig. 2 shows the face of the instrument, upon which the readings are recorded. Six figures are shown which in pump work are usually all that are necessary; more may be supplied as the case may demand.

The drum *B*, Fig. 1, is made exactly 1 foot in circumference and upon it is wound a steel tape which is 0.004 inch in thickness. This tape is attached directly to the piston rod or crosshead of the pump, as in Fig. 3, and when the crosshead has moved 1 foot the drum *B* will have made one complete revolution which is recorded on the unit counter-wheel. Should it move 1 foot 1 inch, the 1 inch will be recorded on the small dial beneath the counter as shown in Fig. 2.

By the introduction of a bevel gear *C D* and bevel pinion *E* it will be seen that while drum *B* is revolving in a clockwise direction, by means of a roller cam shown at *A* it will be seen that the shaft *G* is made to revolve continuously in one direction, thereby affording accurate registry of the total feet travel of the parts to which the meter is attached.

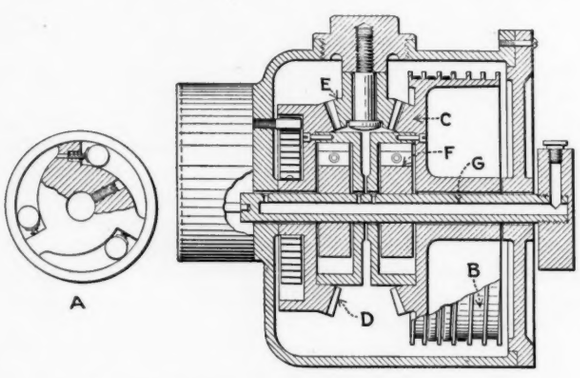


FIG. 1. SECTIONAL VIEW OF THE STROKE RECORDING INSTRUMENT

direction, the drum *F* will be moving in a counterclockwise direction.

As the drums are only engaged to the shaft *G* while moving in a clockwise direction, this instrument may be readily attached to pumps and elevators in various ways. It is manufactured by B. U. Potter, 45 Allyn street, Holyoke, Mass.

New Indicating Boiler Flow Meter

The new FS-2 boiler flow meter, developed by the General Electric Company, Schenectady, N. Y., and shown in Fig. 1, is designed to indicate the total amount of steam generated at any instant by a boiler or a battery of boilers in pounds of steam per hour, or in boiler horsepower. Therefore, it can be advantageously used for obtaining data for equalizing the load on individual boilers or a battery of boilers; for determining stoking efficiency, or correct feed-water circulation; for making known the efficiency loss due to the formation of scale; for discovering internal leaks as shown by the difference in water input and steam output; and for indicating the amount of steam distributed to the de-

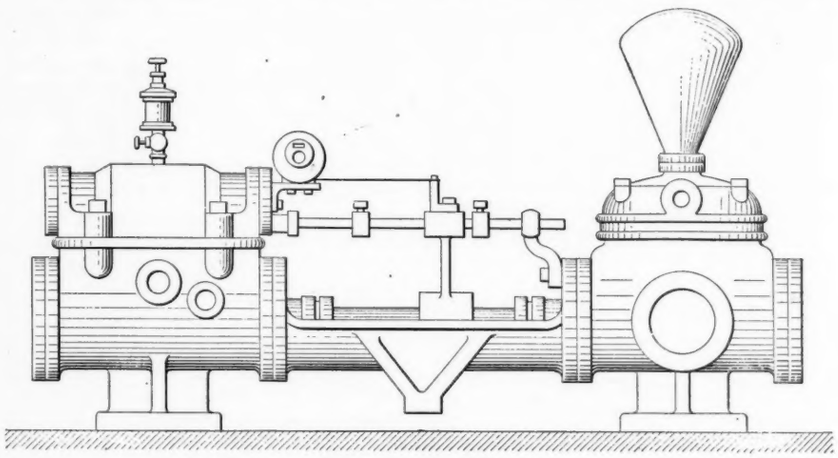


FIG. 3. RECORDER ATTACHED TO A PUMP

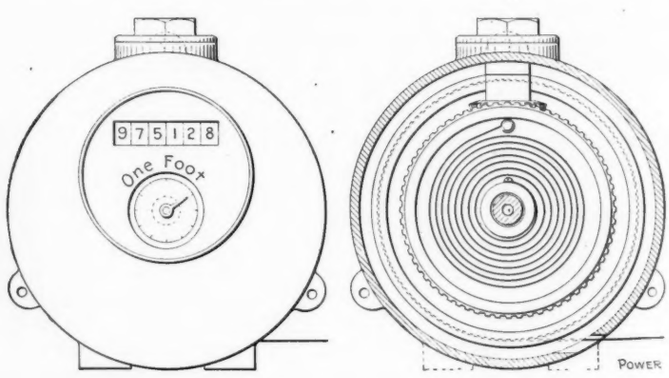


FIG. 2. SHOWING COUNTERS AND SPRING ARRANGEMENT

partments of a manufacturing plant, or used in manufacturing processes. In other words, it is a valuable aid to engineers and firemen in maintaining an intelligent oversight of the fire room.

The meter apparatus complete is composed of a nozzle plug, the meter proper and the necessary pipes for connecting the nozzle plug to the meter.

The nozzle plug is similar to those used with the steam-, air- and water-flow meters made by this company and described in these columns. It consists of a screw plug, provided with a stem having two sets of orifices, a leading set arranged longitudinally and a trailing set comprising three holes located at the middle of the stem and at right angles to the leading set. The interior of the stem is divided longitudinally into two separate compartments, the leading set of orifices opening into one and the trailing set into the other.

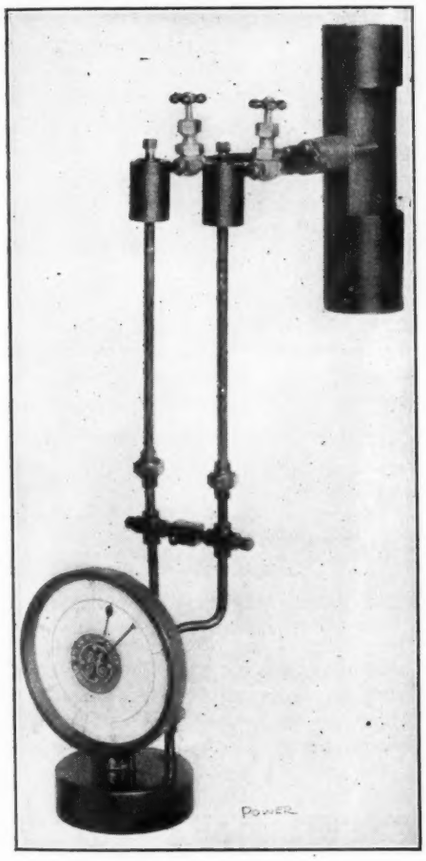


FIG. 1. METER AND PIPING

For operation the nozzle plug, which is shown in Fig. 2, is screwed into a small hole drilled and tapped in the steam pipe, with the stem extending across the pipe and the leading set of orifices facing the direction of steam flow. When thus arranged the velocity of the steam causes a certain difference of pressure in the two sets of orifices, and this difference is communicated through suitable pipes connecting the compartments in the nozzle-plug stem with the U-tube of the meter.

The body of the meter is of iron casting cored out to form one leg and the well of the U-tube, the other leg being formed by one of the nozzle-plug connecting pipes entering the well at the opposite end. The well is filled with mercury, and the rest of the apparatus, including the connecting pipes and the compartments in the nozzle plug, is filled with water.

The movable mechanism of the meter comprises a small float resting on top of the mercury in one of the legs of the U-tube, and attached to a waterproof silken cord passing over a pulley and held taut by a counterbalance weight acting on the pulley in the opposite direction, and a pair of horseshoe magnets, one inside the meter, fastened to the pulley shaft, the other outside the meter fixed to the pivoted end of the indicating needle. The axes of rotation of the two magnets are in line, and their mutual attraction exerted through a copper plug screwed into the side of the meter-body casting compels them to move in unison.

When the difference of pressure in the nozzle plug caused by the velocity of the steam flowing in the steam pipe is communicated to the two legs of the U-tube, the mercury in the well rises or falls in the leg containing the float to a hight proportional to the difference of pressure. The resulting motion of the float rotates the pulley, and the motion of the latter is transmitted through the pair of magnets to the indicating needle. The pair of magnets obviate the use of the troublesome packed joint which would be necessary for transmitting the motion of the pulley inside the meter to the indicating needle on the outside, by means of any form of mechanical connection.

The meter is easily installed without interfering with existing steam-pipe arrangements. The work of installing is simple, requiring the drilling and tapping of a small hole in the steam pipe for the insertion of the nozzle plug. The design of the latter permits of its insertion in pipes running either vertically or horizontally. Care should be taken, however, to select a straight run of pipe of at least 12 pipe diameters in length. The meter itself can be located in any desired place, so long as it is kept below the nozzle plug. Its distance from the nozzle plug is immaterial, though it should be connected with ¼-inch iron pipe of the required length. The best location is on the front of the boilers near the steam gage, in plain view of the fireman and the engineer.

The dial scale is 8 inches in diameter, marked with heavy flow lines and large figures on a white surface for easy reading. A target of conspicuous size shows a certain flow on the scale and can be readily set from the outside.

The meter can be calibrated to read in pounds per hour or in boiler horsepower (30 pounds of steam per hour being taken as equivalent to one boiler horsepower) for pressures ranging from 0 to 250 pounds gage; for quality ranging from 4 per cent. moisture to 260 degrees Fahrenheit, superheat; and for pipe diameters of 2, 3, 4, 6, 8, 10, 12 and 14 inches. Meters calibrated for pipes of larger diameter can be furnished on special order.

It should be noted in this connection that for any given case a meter of this type is calibrated for a certain pressure, quality and pipe diameter, and cannot be used for any other condition.

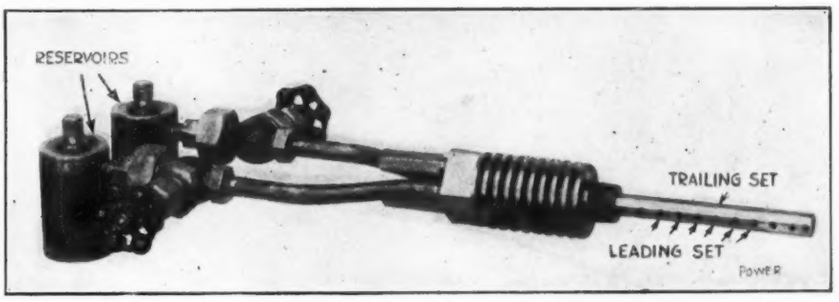


FIG. 2. NOZZLE PLUG AND PIPING FOR STEAM FLOW METER

Transmission Line Calculator

For calculating the line drop and energy loss in alternating-current circuits, Robert W. Adams, 10 Hyde street, Newton Highlands, Mass., has placed on the market an alternating-current transmission-line calculator.

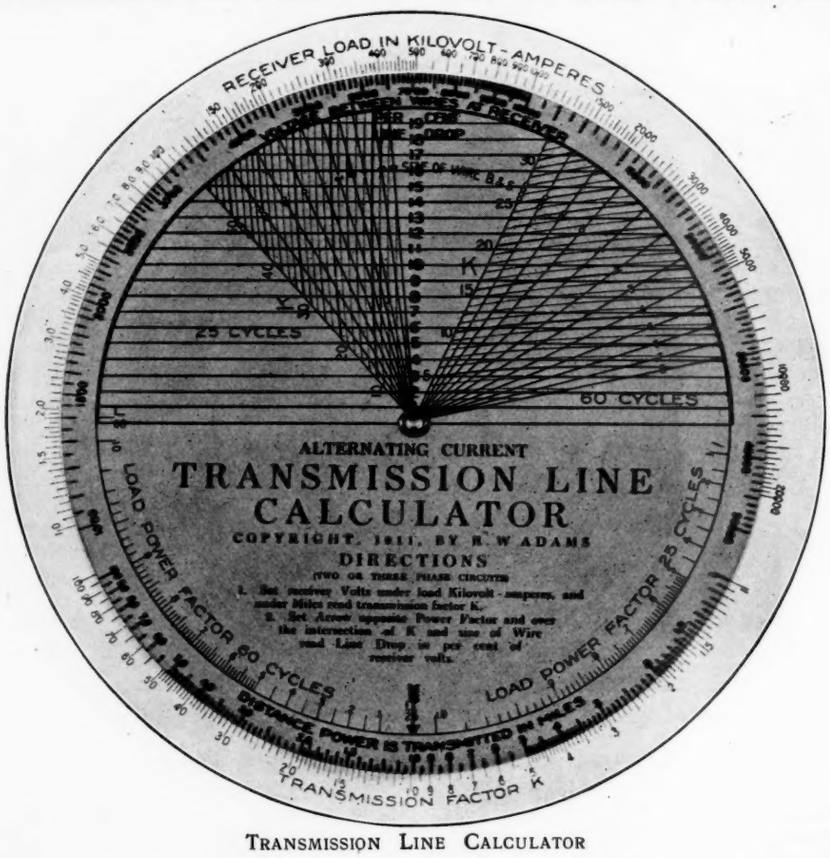
The calculator consists of a stationary disk of opaque white celluloid 4⅛ inches in diameter, and a revolving disk of transparent celluloid $3\frac{9}{16}$ inches in diameter, eyeleted to the stationary disk so as to turn easily upon it. These disks are printed with the necessary diagrams, the stationary diagram in red and the revolving diagram in black to permit easy reading.

The ranges of the various scales are: Load, from 10 to 20,000 kilovolt-amperes; voltage, from 1000 to 50,000; power factor, from 10 to 100 per cent.; distance, from 1 to 100 miles; conductor, from No. 8 to No. 0000 Brown & Sharpe copper; line drop, from 0 to 20 per cent.; frequency, 25 or 60 cycles.

The operation of the calculator is simple; it is only necessary to make two settings to obtain the final results. The value *K*, which is obtained in the first setting, is a transmission factor depending on the load, voltage and distance of transmission. This factor is used directly in the second setting to determine the line drop or "regulation," which is defined as the difference in voltage between the two ends of the line expressed in percentage of the receiver voltage. The method of securing the result includes in an accurate manner the effect of load power factor, which is reversible. This is of value where it is desired to obtain the size of wire necessary to produce a given drop.

Complete directions are printed on the back of the calculator, together with a typical example, and a person having no technical training can quickly learn the method in a few minutes. No book of rules, auxiliary tables or data of any kind are required, which features of the slide rule for solving problems in multiplication and division.

The calculator is based on the use of annealed copper wire at 20 degrees Centigrade (68 degrees Fahrenheit) or hard-drawn copper wire at 15 degrees Centigrade (59 degrees Fahrenheit), and on three-wire three-phase and four-wire two-phase circuits. Single-phase circuits can be calculated as easily as three-phase, although the device is primarily designed for three-phase circuits as being the most common for transmission work. The diagrams are based on a spacing of 18 inches between wires and are sufficiently correct for all practical work on circuits varying from 6-inch to 36-inch spacing.



TRANSMISSION LINE CALCULATOR

device add greatly to its convenience and make it adapted for use in the field.

Upon the back of the stationary disk is also printed a convenient reference table giving the weights and costs of bare and triple-braid weatherproof copper wire per mile of two-, three- and four-wire circuits.

Another advantage is that the two lower revolving scales ordinarily representing distance and transmission factor can also be used as an emergency

Ferrochem for Feed Water Treatment

The treatment of boiler-feed water by electrochemical-mechanical means is not entirely new. A process developed abroad and recently exploited in this country employs a set of perforated aluminum plates over which the water is made to run in a thin stream. The best results are said to be obtained when the plates are exposed to strong sun rays.

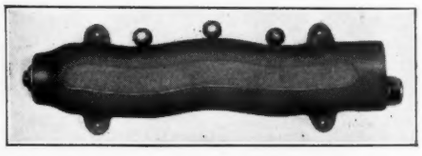
The very latest thing in this line is being put out under the patent name of Ferrochem by the Ferrochem Company, Bradbury building, Los Angeles. It does not need the aid of Old Sol. Just before entering the boiler the feed water is made to swirl through a cast-iron compartment which has an irregular contour and a sectional area two or three times as great as the feed pipe itself.

A nozzle at the inlet of this compartment of smaller diameter than the feed pipe causes the water to enter at a rather high velocity and circulate briskly in the compartment. A number of metal balls, usually three, swash around in the water within the compartment.

It is these balls that are the special feature of the apparatus. The balls are composed for the most part of chemically pure iron, it is said. The balance of their composition is made up of a number of other metallic elements. As the balls wallow around over the rough irregular interior surface of the casting, minute flakes are rubbed off and diffused through the water, and it is said that the scale-forming impurities combine, or react or do something or other with these little flakes so that when they enter the boiler no scale whatever is formed and only a sand-like sediment is discovered when the boiler is opened for cleaning.

Not only is this Ferrochem system said to prevent scale from forming but it is also claimed that it reduces scale which has already formed in the boiler.

The company was not overexplicit in describing its apparatus to the writer because all of its patent claims had not been allowed at the time of his interview. They did, however, refer him to a place in which the device had been employed for several months apparently with success.

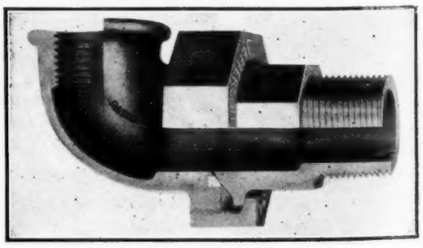


ONE FORM OF FERROCHEM FEED-WATER TREATING MACHINE

No stock in the company is being offered to the public.

Jefferson Union Elbow

The accompanying illustration shows the design of elbow just got out by the Jefferson Union Company, 161 Main street, Lexington, Mass. It is made both male and female. The general construction is the same as that of the other types of union joints manufactured by this firm.



JEFFERSON UNION ELBOW

Improved Detroit Automatic Stoker

In the December 29, 1908, issue of POWER, the Detroit automatic stoker was described and the worm conveyer, or screw feed, and the reciprocating or pusher feed were introduced. The improvements made since are illustrated and described herewith.

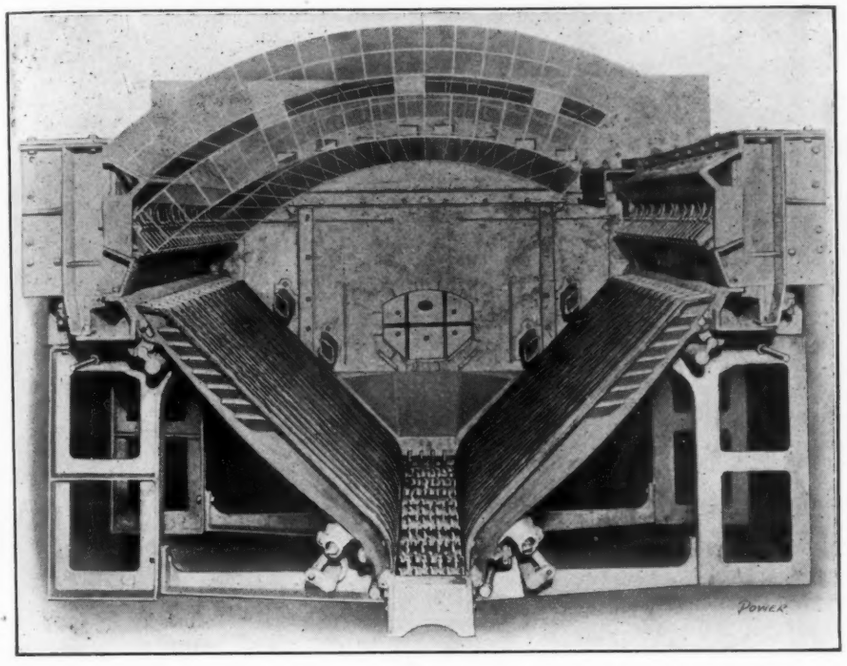


FIG. 1. SHOWING DOUBLE ARCH AND REAR VIEW OF THE RECIPROCATING FEED

In Fig. 1 are shown the double-arch construction, which is still retained, and a rear view of the reciprocating feed. Air, admitted through the front, is heated between the arches and passes through the sectional arch supports into the furnace, directly over the coking coal as it enters at the upper end of the grate on both sides of the furnace.

The pusher boxes are operated with a shaft extending through the front and connected with removable links to the operating bar.

Each alternating grate is operated by the driving bar in front, and may be disconnected when a noncoking or free-burning coal is used.

The movement of the vibrating grates prevents the clinkers from forming on the grates, and at the same time moves the bed of fire down toward the center of the furnace.

If the coal is to be shoveled into the magazines by hand through the front, the movable slides in the top may be closed.

The grates shown in Fig. 2 are of two kinds, vibrating and stationary. The movement of the vibrating grate between the stationary grates eliminates the necessity of poking the fires.

As each grate is independent of each other, their removal is an easy matter, and as the cooling surface is large and as air is admitted under the coking coal the life of the grates is prolonged.

The clinker crusher, Fig. 3, is composed of a row of heavy cast-iron disks, which rotate alternately toward and from each other and crush the clinkers and deposit them in the ashpit below.

The crusher is operated by means of the bell crank connected to the operating bar in front.

The motion of the crushers may be regulated to suit the quantity of ash and clinkers found in the fuel.

The stokers shown in Fig. 4 are arranged for a battery of two boilers. They can be installed with flush front or with extension front, and may be applied to either large or small boilers of all types. Coal can be shoveled in by hand or supplied from overhead bunkers.

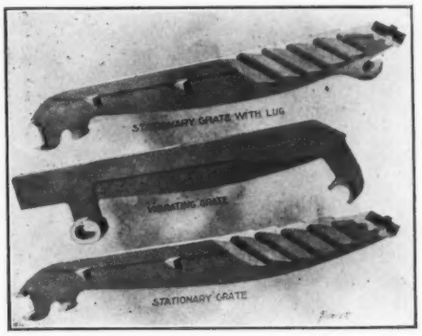


FIG. 2. VIBRATING AND STATIONARY GRATES

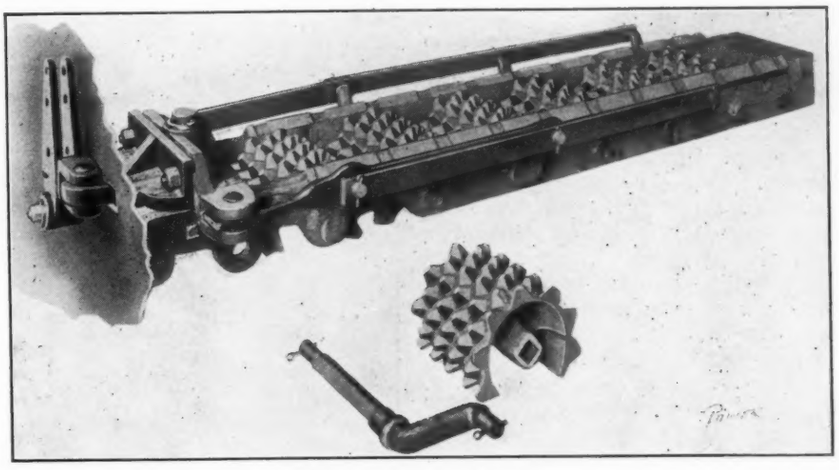


FIG. 3. CLINKER CRUSHER

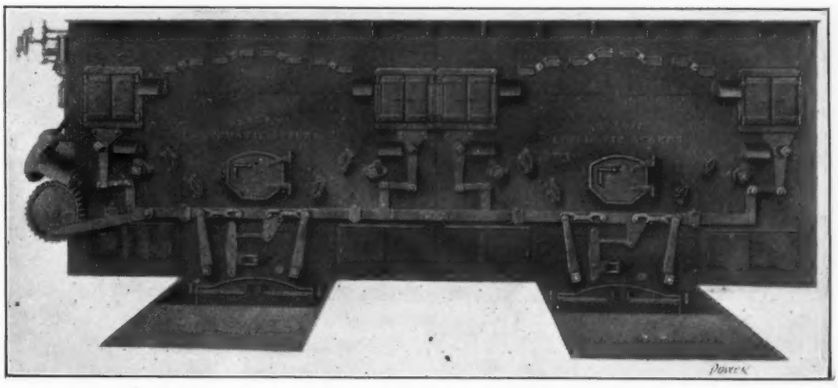


FIG. 4. FRONT OF STOKER AS ARRANGED FOR TWO BOILERS

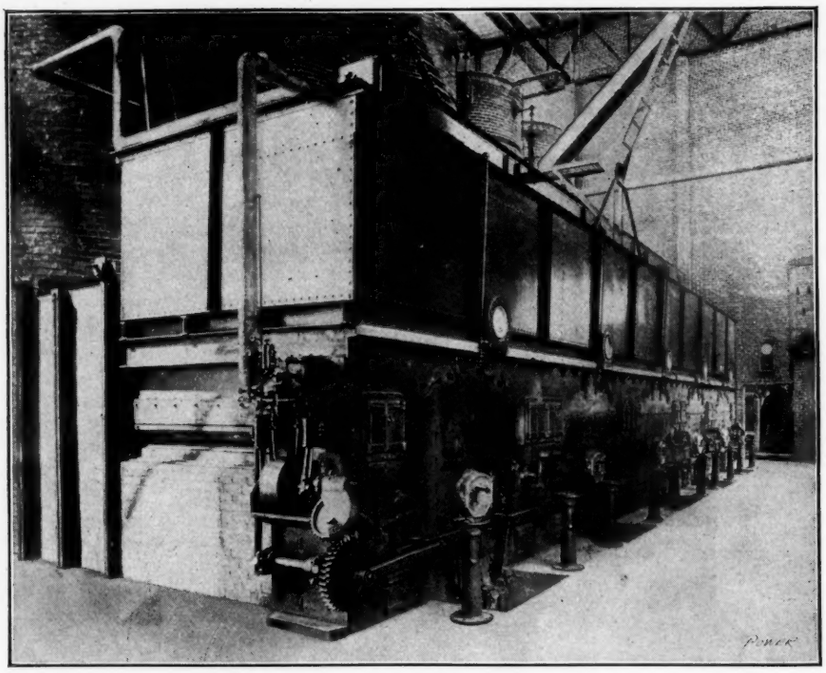


FIG. 5. STOKER ARRANGED TO BE FED BY GRAVITY

Fig. 5 is an illustration of an installation of these stokers. Coal is fed by gravity from the bunkers located on top of the stokers.

This stoker is made by the Detroit Stoker Company, Detroit, Mich.

Hamilton Series "N" Power Pump

A design of power pump, built by the Hooven, Owens, Rentschler Company, Hamilton, O., is illustrated in Fig. 1. This pump is built duplex, double-acting, and the general design comprises two pairs of horizontal water chambers, each pair connected at each end by vertical water passages, and at the center by a vertical working barrel or cylinder, as shown in the sectional view, Fig. 2. The upper water chambers of each pair are connected at each end by arms firmly bolted together in a vertical plane, passing lengthwise through the center of the pump. In each arm there is an intake or discharge opening where a gate valve can be placed. By referring to Fig. 1 it will be seen that by closing one pair of gate valves, one intake and one discharge, the water cannot flow from one pair of chambers to the other, at either end, thus making it convenient to use one side or one-half the pump without using the other half. When inspection is desired, or repairs are necessary, the entire service of the pump is not impaired, which is an important feature.

Each water chamber carries two sets of valves, an intake and a discharge set, one on each side of the vertical cylinder. The valve decks proper are cast as parts of the water chamber, but each deck carries one bronze plate, to which are attached all the valves in that section of the chamber, or that quarter of the pump, regarded as a unit. All valves seat on horizontal bronze plates. When these plates are worn, they can be resurfaced,

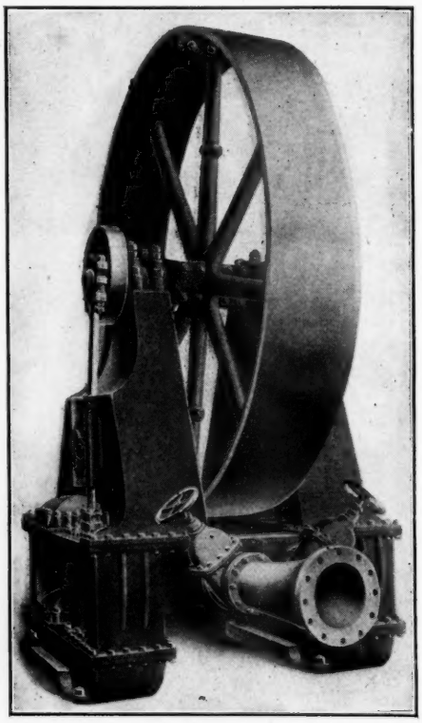


FIG. 1. HAMILTON SERIES N POWER PUMP

or easily exchanged for new ones. The advantage of this valve construction is that all valves open vertically, and the springs act perfectly, thus assuring a quiet running pump. The valve-chamber openings are provided with steel covers which are easily removable, and all valves are readily accessible for inspection or repairs.

Each upper water chamber supports an A-frame, of box section, which forms

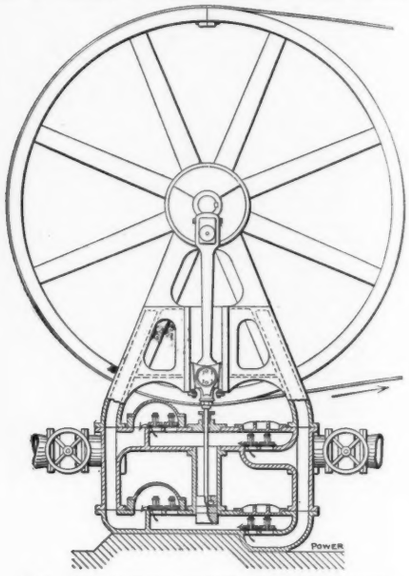
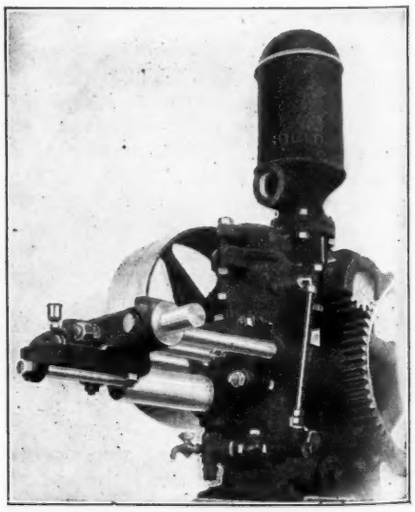


FIG. 2. SECTION THROUGH HAMILTON PUMP

suitable air chambers for both intake and discharge ends. These A-frames are provided with bored guides for the crosshead and journals for the shaft with its disk cranks and pulley. The plunger is grooved, and fits closely in the cylinder, thus reducing the leakage of the water to a minimum. No air can enter the pump chambers by reason of defective plunger packing.

Air Cylinder for Piston Pump

The Goulds Manufacturing Company, Seneca Falls, N. Y., is placing on the market a special air cylinder for attaching to sizes 3x5 and 4x5 inch of the



AAR CYLINDER ATTACHED TO GOULDS PISTON PUMP

Pyramid double-acting piston pump when used for pneumatic water-system pumping.

This air cylinder does away with the necessity of a separate pump for maintaining the required air pressure in pneumatic tank systems. It is designed to operate against a pressure of 75 pounds. Opening the air cock prevents the air from going into the tank and relieves the pump of all pressure when not required. The suction and discharge valves and the cylinder are of brass. The plunger is packed with leather cups and is operated by the piston rod of the pump. The cylinder bracket is held in place by the same bolts that hold the cylinder head. The pipe leading from the air attachment is connected to the drain-plug opening or discharge chamber of the pump. The attachment is shown in the accompanying illustration.

Flywheel Explosion at West Berlin, Mass.

By J. W. Parker

On July 4 an accident caused by the overspeeding of one of the engines occurred at the power station of the Worcester Consolidated Street Railway Company at West Berlin, Mass.

The plant consists of four horizontal return-tubular boilers which carry a gage pressure of 120 pounds, also two horizontal engines, 20x42 inches, of the Corliss type. On each the belt wheel is 16 feet in diameter and the width of the rim is 28½ inches. The engines are run condensing at 88 revolutions per minute and are belted to direct-current generators of about 200 kilowatts capacity.

Due to the overspeeding of one of the engines, the flywheel exploded, completely wrecking the generator to which the engine was belted. One piece of the rim, about 7 feet long, and probably weighing upward of a ton, was hurled through the roof of the building and landed about 400 feet away on one of the New York, New Haven & Hartford lines, breaking off in its flight a large limb of a tree. The jaw of the main bearing was broken off the engine bed and the main shaft together with the bent connecting rod still attached to the crank pin, also the crosshead and piston rod (which had pulled out of the piston, leaving it and the piston-rod nut in the cylinder) were thrown over to the wheel side of the bed and through the floor endwise. The outboard bearing was torn from its bed and thrown through the brick wall of the building. The wrist-plate stud was broken off, also the eccentric connection and various parts of the valve motion.

Fortunately, none of the main steam connections was broken, although a piece of the belt wheel landed on top of one of the boilers and broke the lever of one of the pop safety valves.

Both engines were running when the accident occurred and the flying pieces from the wrecked engine and generator knocked the brush attachment off the generator driven by the other engine and put it out of commission. This left the station in darkness and the engineer, in groping about in the darkness to find the throttle valve and shut off the steam, fell through a hole broken through the floor and fractured one of his arms.

The armature windings were torn loose and in a tangled mess radiated from the center of the shaft. Pieces of the generator pulley were lying about the floor, something heavy having struck the wheel with such force as to bend the shaft and turn the entire machine more than a quarter of the way around from its original position.

The governor of the duplicate engine is belted from the bare shaft of the engine. Consequently, the governor pulley is of small diameter. The governor pulleys on both engines were not provided with flanges to prevent the governor belt from running off. The safety-stop device is arranged with a small flanged pulley riding on the governor belt, which in the event of the belt breaking or running off is intended to drop and through connecting mechanism prevent the latches of the steam valves engaging and thus stop the engine. Evidently the safety device failed to work and the wreck resulted.

Massachusetts N. A. S. E. State Convention

The sixteenth annual Massachusetts State convention of the National Association of Stationary Engineers was held at Worcester, July 13, 14 and 15, with headquarters at the Bay State hotel.

The business of the convention was conducted in the Mechanics building. The committee is to be congratulated for its wise selection of this hall, which was situated almost adjacent to the headquarters.

There was the usual large attendance of delegates, and the meetings were held in Washburn hall on the main floor of the building.

The spacious auditorium on the second floor was conveniently arranged and neatly decorated for the use of the supplymen for their mechanical display. The exhibit was opened to the public on Thursday morning, and was liberally patronized.

The convention was formally opened on Friday morning at 10 o'clock. A. G. Lamb, chairman of the convention committee, called the meeting to order and introduced Mayor James Logan who warmly welcomed the delegates and guests to Worcester. Past National President Herbert E. Stone responded for the engineers. Edward M. Woodward, president of the board of trade; Fred L. Johnson, of Power; Mrs. Nella C. Moore, president of the ladies' auxiliary of the New England States, and National Vice-president Edward H. Kearney also made interesting addresses. At the close of these ceremonies, State President George L. Finch took charge of the meeting, and upon taking the chair was presented a silver-mounted gavel, made from wood grown in the heart of the Bay State, the gift of the members of the State body. After his speech of acceptance, Mr. Finch appointed the necessary committees, when an adjournment was taken until 2 p.m.

At the afternoon session a committee of five was appointed to confer with the members of the other New England associations regarding the advisability of forming a New England District Association. The delegates were quite enthusiastic in this movement, as it would give the larger bodies in Massachusetts and Connecticut an opportunity to assist the weaker associations in Maine, New Hampshire, Vermont and Rhode Island.

It was decided to hold the next annual convention at Northampton.

The final business of the convention was the election of State officers, which resulted as follows: James H. Sumner, president, of Cambridge; J. T. Maloney, vice-president, of Fall River; Ole B. Peterson, secretary, of Boston; Walter B. Damon, treasurer, of Springfield; Almond F. Cheney, conductor, of Milford; John H. Parker, doorkeeper, New Bedford. Charles J. Wilder, of Worcester, after a close contest was chosen as State deputy.

The supplymen held a meeting on Friday afternoon, and, following the lead of the delegates, formed what will be known as the New England Commercial Engineers' Association, for which the following officers were elected: Claude Allen, president, of Garlock Packing Company; H. B. Aller, vice-president, Manning, Maxwell & Moore; Edward F. de Grouchy, secretary, *New England Engineer;* Herbert E. Stone, treasurer, Elliott Company.

The following comprise the board of directors: Thomas Burke, Burke Engineering Company; Gordon Hall, Enterprise Rubber Company; T. A. Collins, Philadelphia Grease Manufacturing Company; W. W. Beal, Lunkenheimer Company.

There were several features of entertainment.

On the evening of July 13 the engineers were entertained by the supplymen in the grill room of the Bay State hotel. Songs, stories and recitals were interspersed with addresses. F. E. Ransley presided. Refreshments were served.

Visits were made to the Worcester Polytechnic Institute and to the Worcester School of Trades on Saturday morning.

On Friday evening a smoker was tendered to the engineers by the supply-

men, at Washburn hall. There was a most interesting and varied program of entertainment. Hardy's orchestra opened with musical selections; William F. Prizer, Vacuum Oil Company, sang baritone solos; W. E. Percy, of Worcester Association No. 4, told stories and recited; Joe McKenna, of Jenkins Brothers, sang popular songs; Jim Devins, of the Peerless Rubber Manufacturing Company, told laughable stories; Billy Murray, of Jenkins Brothers, rendered several uptodate ditties, and Jack Armour, of POWER, closed the evening's fun with stories, etc. Between the acts National Vice-President Kearney presented Past State President Finch a signet ring and a silver service, from the members of the State organization and supplymen. Mr. Kearney also distributed the educational prizes for the 1910-1911 contest to the members of Worcester No. 4, as follows: A. C. Luft, first prize; C. G. Bergland, second, and James Hickey, third prize. The prizes were valuable and appropriate. The A. W. Chesterton Company had a drawing for a handsome gold watch, which was won by W. A. Edmundson. The Aschroft Manufacturing Company presented a steam-engine indicator, which was drawn for and was won by M. H. Bolton, of Worcester Association No. 4.

At twelve o'clock on Saturday afternoon, special cars carried the company to Fern Grove, Lake park, where a light lunch was partaken of, after which the annual baseball match between the engineers and supplymen took place, resulting in a victory for the engineers by the score 15 to 11. This being the third consecutive year that the engineers have been victorious, they have therefore won permanently the pennant.

At the close of the ball game the steamer was taken for a sail across the lake to White City, where an appetizing banquet was served. Outdoor amusements brought the pleasant day and the convention to a close.

The Ladies' Auxiliary convened at the Warren hotel on Friday and Saturday and transacted considerable important business.

About eighty firms had exhibits as follows:

Ackley & Brink Manufacturing Company, Albany Lubricating Company, American Metal Hose Company, American Oil Company, American Steam Gauge and Valve Manufacturing Company, George P. Anderson, Ashton Valve Company, Autogenous Welding Equipment Company, Bishop & Babcock Company, J. Henry Blanchard, Braman-Dow Company, Builders' Iron Foundry, Burke Engineering Company, Central Supply Company, A. W. Chesterton Company, Charles A. Claflin & Co., Cling-Surface Company, Coates Clipper Manufacturing Company, Connecticut Boiler Cleaner Company, Crandall Packing Company, M. T. Davidson Company, Dearborn Drug and Chemical Works, E. Dugar, Eagle Oil and Supply Company, Economy Instrument Company, Economy Lubricating Company, Elliott Company, Enterprise Rubber Company, G. L. Fairbanks & Son, Federal Metallic Packing Company, Garlock Packing Company, Graton & Knight Manufacturing Company, Greene, Tweed & Co., Hart Packing Company, Hartford Mill Supply Company, Hills-McCanna Company, Hinckley & Ramsay, Hudson Belting Company, W. J. Hyland Manufacturing Company, Home Rubber Company, Ironworks Company, Jenkins Brothers, H. W. Johns-Manville Company, Keystone Lubricating Company, George W. Knowlton Rubber Company, Lagonda Manufacturing Company, Lubron Company, Lunkenheimer Company, Mason Regulator Company, Manning, Maxwell & Moore, Massachusetts School of Engineering, Max Machine Company, McLeod & Henry Company, Monarch Valve and Manufacturing Company, *National Engineer,* Nelson & Shattuck, *New England Engineer,* Nightingale & Childs, Peerless Rubber Manufacturing Company, Perfection Grate Company, Patterson Lubricating Company, William Powell Company, POWER, *Practical Engineer,* Philadelphia Grease Manufacturing Company, Quaker City Rubber Company, Reynolds Oil Company, P. L. Rider Rubber Company, Walter C. Ruggles Company, *Southern Engineer,* Strong, Carlisle & Hammond Company, Tillotson Humidifier Company, Universal Lubricator Company, Vacuum Oil Company, Washburn & Garfield Manufacturing Company, L. J. Wing Manufacturing Company, W. R. Winn.

Boiler Manufacturers' Convention at Boston

The twenty-third annual convention of the American Boiler Manufacturers' Association was held at the Hotel Brunswick, Boston, Mass., July 10 to 13. The association was welcomed to the city by Walter L. Collins, acting mayor, whose greeting was accepted in behalf of the association by President E. D. Meier.

The meeting was fairly well attended, and, although no formal papers had been prepared, ample material for discussion and consideration was found in the reports of the various committees and in the topical questions submitted by the committee on data.

Suitable resolutions were passed to the memory of James Lapham, one of the founders of the organization whose death occurred since the last meeting, and H. J. Hartley, of Philadelphia, another of its founders, was made an honorary member.

The entire board of officers was reelected with the exception of M. A. Ryan as fifth vice-president. Mr. Ryan's company having withdrawn, M. H. Broderick, of Muncie, Ind., was elected to this office. E. D. Meier, of New York, continues as president and J. D. Farasey, of Cleveland, O., secretary. The next meeting will be held in New Orleans.

The social features connected with the convention consisted of an informal reception at the Brunswick on Monday evening; an automobile trip for the ladies on Tuesday and on Tuesday evening a visit to Norunbega park; on Wednesday afternoon and evening a trip to Nantasket beach, with a shore dinner at the Palm gardens, Paragon park; on Thursday morning an automobile trip to points of historic interest in and about the city, and on Thursday evening a banquet.

The committee reports and discussions will be available for a later issue.

First Annual Convention of Institute

The first annual convention of the Institute of Operating Engineers will be held in New York City, Friday, Saturday and Sunday, September 1, 2 and 3. The sessions of the convention will be held in the Engineering Societies building, 29 West Thirty-ninth street, New York City, and much business of importance will be transacted in the way of adopting the constitution, bylaws, educational requirements, apprenticeship requirements, regular study courses, lists of books, etc. The first day's session will consist of addresses by prominent speakers, the appointment of committees and allotting of work to them. The second day's session will be taken up with the executive business of the institute. The third day's session will be given over to sightseeing. Special rates will be provided for all those who attend the convention. All those who expect to attend this convention are requested to write at once and notify Secretary Hubert E. Collins, 29 West Thirty-ninth street, New York City.

PERSONAL

H. T. Fryant has resigned from his position with the Mechanical Rubber Company, which he has held for the past five years, and has opened an engineering office in Jackson, Miss. He will be in a position to do indicator work and conduct a general-repair business.

R. H. Fenkhausen, who for the past six years has been chief electrician at the Risdon Iron and Locomotive Works, on July 1 entered the service of the Union Iron Works Company, of San Francisco, as electrical engineer. Mr. Fenkhausen is well known to our readers as the author of some of the best practical articles on electrical engineering that have ever appeared in POWER.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

HERE is the policy that makes the advertising and selling of Cammeyer shoes successful to the tune of over a million pairs of shoes a year, which they say is the largest shoe business in the world—

"We are sticklers for quality all the time—

But, after, all, we are human, and once in a while will err.

The point:—"If this pair of shoes in your opinion does not 'make good,' come in and tell us about it and we'll make it right."

Advertising on this principle sells goods because it sells protection and guaranteed satisfaction with them.

It is the basis on which every successful advertiser is working today.

It is the method that has made advertising the world's greatest salesman—the one that comes out in the open, tells the truth about a product and offers to back up every claim and statement with "satisfaction or money back" guarantee.

Nothing is safer nowadays than buying advertised goods.

The very fact that they are continuously advertised is your insurance.

The element of risk and the fear of being "stung" no longer exist.

The manufacturer is *sure* he has a *good* product before he backs it with an advertising appropriation—then *he* takes all the risk that the buyer used to take.

Because, barring an occasional unpreventable error, there is no risk.

Advertising has eliminated it by automatically weeding out the poor products.

No advertising can be successful unless it is backed by a good article that will stand up to all claims.

Remember, when you turn to the Selling Section, that the ads are working for you. Read them.

BUSINESS ITEMS

The Homestead Valve Manufacturing Company, Pittsburg, Penn., has appointed Chas. B. Scott & Co., 119 Franklin avenue, Scranton, Penn., its agents in Scranton and vicinity.

The American Steam Gauge and Valve Manufacturing Company announces that Gardner Cornett, its vice-president, is now permanently located at the company's office, 30 Church street, New York, N. Y. This office is under the management of Charles A. Allen, who has been connected with the company for many years.

Warren Webster & Co., Camden, N. J., have just published a pamphlet entitled "Webster Vacuum Heating System in the Boston City Hospital." It describes the installation in the face of unusual obstacles of their "Hy-Lo" or type "D" system in 26 buildings of this hospital. The pamphlet will be gladly sent to interested parties if they will write the company at Camden, N. J.

The American Ship Windlass Company, Providence, R. I., reports two notable orders just received for Taylor stokers. The first is for twelve stokers for the New York Edison Company, making a total installation in the Waterside station of Taylor stokers for 52,650 horsepower of boilers. The second is for five Taylor stokers for the United States naval gun factory, at Washington, D. C. These stokers are to be used under 300-horsepower B. & W. boilers.

NEW EQUIPMENT

Central Falls, R. I., will extend its sewer system.

Prince Albert, Sask., will equip a new power station.

Sarnia, Ont., will equip a new electric-lighting plant.

Burnaby, B. C., will install a new waterworks system.

Rowley, Mass., will enlarge its electric-lighting plant.

Centralia, Wash., contemplates installing a waterworks system.

Royalton, Vt., contemplates installing a water-supply system.

Nanaimo, B. C., will install a new station and a new sewage system.

Hamilton, Ont., will spend $500,000 on new power and light equipment.

Geo. Johnson, Arlington, S. D., will install an electric-lighting system.

The Chattanooga (Tenn.) Railways is erecting a new power house.

Kentwood, La., is contemplating issuing $50,000 bonds for waterworks.

Marlboro, Mass., has voted $15,000 bonds for extending its sewer system.

Shelton, Wash., has voted $15,000 bonds for installing a sewer system.

The Pomona (Cal.) Investment Company is to install a central power plant.

The Milford (Mass.) Light and Power Company will add new equipment.

The Huntington Beach (Cal.) Water Company will install a new pumping plant.

The Covina (Cal.) Irrigating Company has plans for a new power house at Irwindale.

Yale University, New Haven, Conn., will build an electric-lighting and heating plant.

The Berkshire Street Railway Company will construct a new power house in Lee, Mass.

Garden City, Kan., will vote on issuance of $40,000 bonds for municipal electric-light plant.

Camden, N. J., voted to spend $1800 for installing another unit in the municipal light plant.

The Deeth (Nev.) Mercantile Company is planning to install a new electric-lighting plant.

The city council, Ellensburg, Wash., is planning the installation of a waterworks system.

Sylvan Grove, Kan., voted to issue $35,000 bonds for electric-light plant and waterworks system.

Porterville, Cal., plans to make improvements in its waterworks system to cost $50,000.

A municipal ice plant may be installed by the city of Cleveland, Ohio. A. B. Lee, city director.

The Pacific Gas and Electric Company, San Francisco, Cal., will erect a substation at Stockton.

Fire destroyed the plant of the Ness City (Kan.) Mill, Light and Ice Company. Loss, $100,000.

The Cincinnati (Ohio) Traction Company is building an addition to its Pendleton power station.

The Indianapolis (Ind.) Light and Heat Company will build an addition at Eighteenth and Mill streets.

New additions are to be made in the power plant of the Castle Inn, at the Delaware Water Gap, Penn.

The city of Providence, R. I., will install two new 100-horsepower boilers in the Technical high school.

The village council, Newbury, Mich., will spend $4000 for installing additional machinery at light plant.

Harrison, Mich., has issued $8000 bonds to extend and improve its electric-light and waterworks system.

The Seitz Brewing Company, Easton, Penn., is to enlarge its brewery and make additions to its power plant.

The St. Petersburg (Fla.) Investment Company is considering plans for the construction of power plant, etc.

The Oberlin (Ohio) Gas and Electric Light Company has increased its capital and will make improvements.

The Consolidated Gas and Electric Company, San Diego, Cal., will build a new $25,000 boiler house.

The Pacific Gas and Electric Company, San Francisco, Cal., will increase the capacity of its gas works in Sacramento.

The Massachusetts Legislature has reported favorably on installing a new boiler in the State asylum at Worcester.

The Spring Valley Water Company, San Francisco, Cal., is planning to build a new pumping plant at Lake Merced.

The Canadian Pacific Northwest Fisheries Company, South Bend, Wash., is planning to install a new cold-storage plant.

The Pacific Power and Light Company, Portland, Ore., will increase the capacity of its power plant at Prosser, Wash.

The Cleveland (Ohio) Southwestern & Columbus Railroad Company is planning to erect a power house in Ashland, Ohio.

The Republic Railway and Light Company will make improvements in its power house at Youngstown, Ohio, and other points.

A refrigerating plant will be installed in the new dairy buildings to be erected by M. Heischhacker, Woodside, near Redwood City, Cal.

The Pacific Power and Light Company, Portland, Ore., is planning to increase the capacity of its power plant at Hood River, Ore.

The Consumers Power Company, of St. Paul, Minn., will spend $10,000,000 on improvements to its several power plants in the State.

The Statler Hotel Company, Cleveland, Ohio, will erect a new $1,000,000 hotel. Power, electrical and refrigeration machinery will be required.

The plant of the Mooresville (Ind.) Water, Light, Heat and Power Company was partially wrecked by a flywheel explosion and much machinery damaged.

The Board of Supervisors, Los Angeles, Cal., will receive bids August 31 for two engine-generator sets for the Hall of Records. H. J. Lelande, county clerk.

Plans have been completed by State architect, W. C. Knighton, Salem, Ore., for a new insane hospital to be erected at Pendleton. These include power plant, refrigerating and cold-storage plant.

The Citizens Electric Company, Charleston, W. Va., has been incorporated with $25,000 capital to manufacture electricity for light and power by Thos. C. Bowling, G. G. Moore, G. E. Hughes, etc.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Salesmen traveling among engineers to sell Ideal metallic packing on commission. Ideal Metallic Packing Co., South Stillwater, Minn.

WANTED—Chief engineer to take charge of power plant, three buckeye engines and low pressure turbine, total 2000 horsepower; state wages wanted. Box 463, POWER.

WANTED—Salesmen or engineers who can sell grates, to represent the Shear Klean rocking and shearing grates. Address Chicago Grate Company, Monadnock Block, Chicago, Ill.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

SALESMEN to sell new and improved boiler compound in the States of Ohio, Indiana, Illinois and Wisconsin; good salary and expenses to competent men; in making application give age and state experience. Address "Boiler Compound," Box 456, POWER.

ENGINEER—First class steam engineer with a New York City license wanted in a plant of 3000 horsepower in New York City; must be capable of handling men and familiar with ice machinery and elevators. Write, stating age, experience and salary expected. Address "Ice," Care POWER.

SUPERINTENDENT metal department of a large manufacturing concern; one who thoroughly understands the making and finishing of articles from sheet metals; no one who is not thoroughly experienced need apply; permanent position to right party. Address "Metal Expert," Box 464, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

THOROUGH, PRACTICAL chief engineer, who can produce results, desires to change

his position; competent to handle large steam or gas power plants; married; furnish the best of reference. Box 465, POWER.

POSITION WANTED by married man, sober and reliable of 12 years' experience, understands alternating and direct current electricity and ice machinery; can give good reference. Address Geo. Abel, Ness City, Kan.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

WANTED—The opportunity to help you solve your fuel problems, write me. C. E. Wertz, Consulting Fuel Engineer, Bowles building, Detroit, Mich.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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By intelligent use of the coal the fireman can save money for you. But carelessness, indifference or negligence on his part means coal waste and money loss. The

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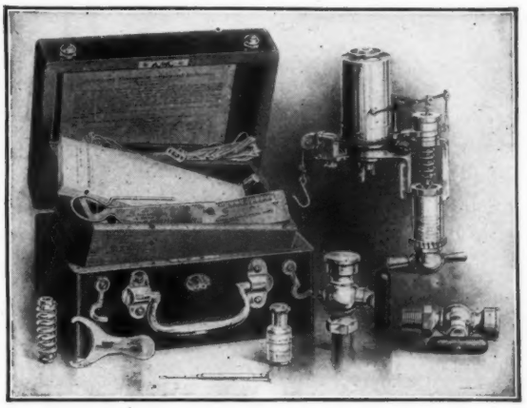

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And I left 'em sweating and stealing a year and a half behind.—*Kipling.*

You will find any number of imitations of the American-Thompson.

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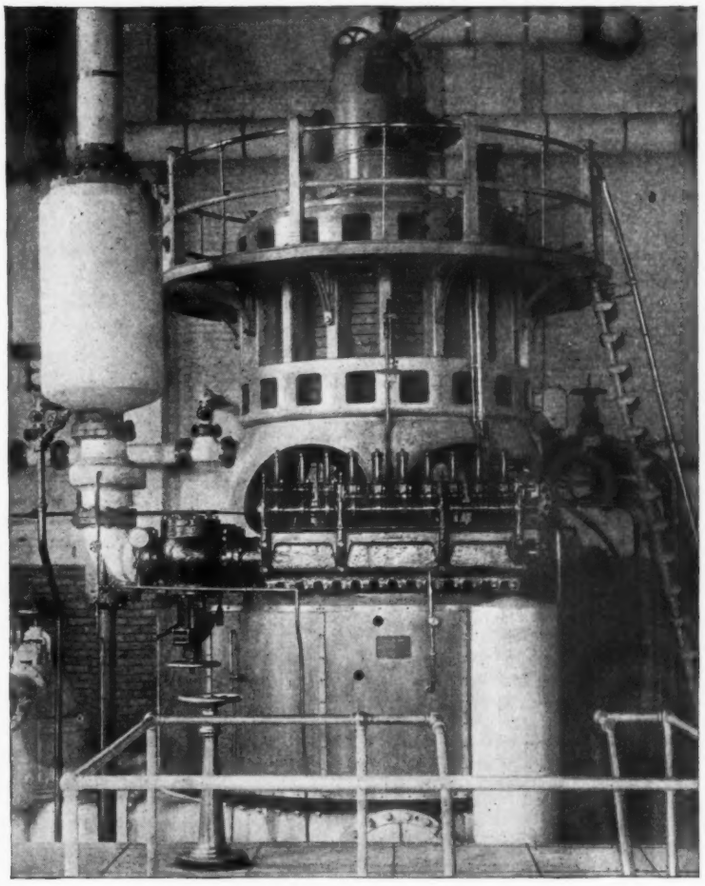

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Reliance Gauge Column Co...102
Rogers Co., H. A..... 73
Schutte & Koerting Co..... 92
Squires Co., C. E..... 75
Watson & McDaniel Co..... 96
Wright Mfg. Co..... 74

Traps, Vacuum
Griscom-Spencer Co. 72
Lytton Mfg. Corporation..... 75
Morehead Mfg. Co..... 74
Nashua Machine Co..... 75
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Tube Cleaners
Bayer Steam Soot Blower Co.104
Chesterton Co., A. W..... 89
Elliott Co. 7
Garlock Packing Co..... 9
Johns-Manville Co., H. W.... 73
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7
Parson Mfg. Co..... 87
Pierce Co., Wm. B.....2d cover
Robertson & Sons, Jas. L.... 77

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St. John, G. C..... 90
Simonds & Co., G. L.....100
Vulcan Soot Cleaner Co.....100

Tube Cutters
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Liberty Mfg. Co..... 7

Tubing
Johns-Manville Co., H. W.... 73
National Tube Co..... 94

Tubing, Metallic
Pennsylvania Flexible Metallic Tubing Co.....109

Turbines, Hydraulic
Allis-Chalmers Co.....110

Turbines, Steam
Allis-Chalmers Co.....110
De Laval Steam Turbine Co..112
General Electric Co.....106
Hooven, Owens, Rentschler Co.115
Sturtevant Co., B. F..... 110
Terry Steam Turbine Co.....109
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Dart Mfg. Co., E. M..... 92
Jefferson Union Co..... 10
Lunkenheimer Co..... 4
National Tube Co..... 94

Valve Balls
Diamond Rubber Co..... 89

Valve Disks
Diamond Rubber Co..... 89

Valve Washers, Leather
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Valves, Ammonia
Chapman Valve Mfg. Co..... 94
Monarch Valve & Mfg. Co.... 94

Valves, Angle
Homestead Valve Mfg. Co.... 94
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co.... 94
National Tube Co..... 94
Nelson Valve Co., 90, 91, 93 and 95
New Bedford Valve Mfg. Co.. 94
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Valves, Back Pressure
Hughson Steam Specialty Co. 95
Jenkins Bros. 65
Perkins, Jno. B..... 95

Valves, Blow-off
Ashton Valve Co., The..... 95
Elliott Co. 7
Homestead Valve Mfg. Co.... 94
Jenkins Bros. 65
Lunkenheimer Co..... 4
Lytton Mfg. Corporation..... 75
Yarnall-Waring Co.....4th cover
Ziermore Regulator Co.....103

Valves, By-Pass
Nelson Valve Co., 90, 91, 93 and 95

Valves, Check
Greene, Tweed & Co., 84 and 4th cover
Jenkins Bros. 65
Lunkenheimer Co..... 4
National Tube Co..... 94
Nelson Valve Co., 90, 91, 93 and 95

Valves, Cylinder Relief
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co..... 95
Lunkenheimer Co..... 4
Perkins, Jno. B..... 95
Star Brass Mfg. Co..... 97

Valves, Exhaust Relief
Alberger Pump Co..... 99
Jenkins Bros. 65

Valves, Float
Schade Valve Mfg. Co..... 92

Valves, Free Exhaust
Davis Regulator Co., G. M.... 94
Schutte & Koerting Co..... 92

Valves, Gate
Chapman Valve Mfg. Co..... 94
Detroit Lubricator Co..... 84
Greene, Tweed & Co., 84 and 4th cover
Jenkins Bros. 65
Lunkenheimer Co..... 4
Monarch Valve Co. 94
National Tube Co..... 94
Nelson Valve Co., 90, 91, 93 and 95
Pittsburgh Valve, Fdry. & Construction Co..... 94

Valves, Globe
Detroit Lubricator Co..... 84
Jenkins Bros. 65
Lunkenheimer Co..... 4
National Tube Co..... 94
Nelson Valve Co., 90, 91, 93 and 95
New Bedford Valve Mfg. Co.. 94
Pittsburgh Valve, Fdry. and Construction Co..... 94
Star Brass Mfg. Co..... 97

Valves, Piston
Baker Valve Co.....110

Valves, Pump
Garlock Packing Co..... 9
Jenkins Bros. 65
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8
Schade Valve Mfg. Co..... 92

Valves, Reducing
Davis Regulator Co., G. M.... 94
Lytton Mfg. Corporation..... 75
Mason Regulator Co..... 94

Valves, Regrinding
Lunkenheimer Co..... 4
National Tube Co..... 94
Nelson Valve Co., 90, 91, 93 and 95

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Davis Regulator Co., G. M.... 94
Engineers Appliance Co., The. 94
Hughson Steam Specialty Co.. 95
Lunkenheimer Co..... 4
Lytton Mfg. Corporation..... 75
Mason Regulator Co..... 94
Nelson Valve Co., 90, 91, 93 and 95
Schade Valve Mfg. Co..... 92

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Valves, Safety
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co..... 95
Crosby Steam Gage & Valve Co. 93
Detroit Lubricator Co..... 84
Jenkins Bros. 65
Lunkenheimer Co..... 4
National Tube Co..... 94
Pittsburgh Valve, Fdry. and Construction Co..... 94
Star Brass Mfg. Co..... 97

Valves, Stop Check
Jenkins Bros. 65
Lagonda Mfg. Co.....3d cover
Perkins, Jno. B..... 95
Schutte & Koerting Co..... 92

Valves, Tank
Nelson Valve Co., 90, 91, 93 and 95

Valves, Throttle
Detroit Lubricator Co..... 84

Valves, Trip Throttle
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Elliott Co, ... 7
Huyette Co., P. B..... 68
Lunkenheimer Co..... 4
National Tube Co..... 94
Reliance Gauge Column Co...102
Robertson & Sons, Jas. L.... 77
Wright Mfg. Co..... 74

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Kennicott Co.....104
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Ashton Valve Co..... 95
Lunkenheimer Co..... 4
Star Brass Mfg. Co..... 97

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Trimont Mfg. Co..... 96
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Trimont Mfg. Co..... 96
Williams & Co., J. H..... 71